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A Guide to Lead Exposure in the Construction Industry

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Acknowledgment

A Guide to Lead Exposure in the Construction Industry is based upon the U.S. Department of Labor's Program Highlights fact sheet series (Fact Sheet No.'s OSHA 93-47 through 93-52) concerning the topic of lead in construction, combined with information from a U.S. OSHA booklet titled *Lead in Construction* (OSHA 3142). Additional material was provided by North Carolina Department of Labor Health Standards Officer J. Edgar Geddie, Ph.D., and Health Compliance Supervisor Paul Sullivan.

This guide is intended to be consistent with all existing OSHA standards; therefore, if an area is considered by the reader to be inconsistent with a standard, then the OSHA standard should be followed.

To obtain additional copies of this book, or if you have questions about N.C. occupational safety and health standards or rules, please contact:

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Additional sources of information are listed on the inside back cover of this book.

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Foreword

Lead is a cumulative and toxic substance. People who swallow or inhale lead compounds may become ill or die from lead poisoning. Although lead is eliminated from the body at a slow rate, inhaling even a small amount of a lead compound over an extended period of time may cause lead poisoning. Immediate symptoms of disease may not be noticeable. As the blood is circulated through the body, lead is stored in various organs and body tissues. The lead stored in the body may be slowly causing irreversible damage: first to the cells, then to the organs, and finally to the whole body system.

Employers must be aware of workplace hazards facing their workers and must take appropriate action to minimize or eliminate exposure to these hazards. *A Guide to Lead Exposure in the Construction Industry* discusses precautions that can prevent serious health risks to workers due to exposure to lead compounds.

In this state, North Carolina Department of Labor consultants and inspectors administer the federal OSHA laws through a plan approved by the U.S. Department of Labor. All current OSHA standards are enforced. Many educational programs, publications (including this guide), and other services are also offered to help inform people about their rights and responsibilities regarding OSHA.

As you look through this guide, please remember that OSHA's mission is greater than just enforcement. An equally important goal is to help citizens find ways to create safe and healthy workplaces. Reading and using the information in this booklet, like other educational materials produced by the North Carolina Department of Labor, can help.

Cherie K. Berry
Commissioner of Labor

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Introduction

Health Hazards of Lead Exposure in the Construction Industry

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. When absorbed into the body in certain doses lead is toxic. It can be absorbed into the body by inhalation and ingestion. Except for certain organic lead compounds not covered by OSHA's interim 1926.62 standard, lead is not absorbed significantly through the skin. When scattered through the air as a dust, fume, or mist, lead can be inhaled and absorbed through the lungs and upper respiratory tract. Inhalation of airborne lead is generally the most important source of occupational lead absorption. Lead also can be absorbed through the digestive system if it enters the mouth and is ingested.

A significant portion of the lead inhaled or ingested gets into the blood stream. Once in the blood stream, lead is circulated through the body and stored in various organs and body tissues. Some of this lead is quickly filtered out of the body and excreted, but some remains in the blood and tissues. As exposure continues, the amount stored will increase if the body is absorbing more lead than it is excreting. The lead stored in the tissues can slowly cause irreversible damage, first to individual cells, then to organs and whole body systems.

Long-term (chronic) overexposure to lead may result in severe damage to the blood-forming, nervous, urinary, and reproductive systems. Some common symptoms include the following:

loss of appetite	hyperactivity
constipation	muscle and joint pain
excessive tiredness	or soreness
headache	weakness
fine tremors	anxiety
colic with severe	pallor
abdominal pain	insomnia
metallic taste	numbness
nervous irritability	dizziness

Damage to the central nervous system in general and the brain in particular is one of the most severe forms of lead poisoning. Chronic overexposure to lead also significantly impairs the reproductive systems of both men and women. Lead can alter the structure of sperm cells, raising the risk of birth defects, and there is evidence of miscarriage and stillbirth in women exposed to lead or whose husbands have been exposed to lead. Children born of parents who were exposed to excess lead levels are more likely to have birth defects, mental retardation, behavioral disorders, or to die during the first year of childhood.

The interim OSHA standard aims to reduce the exposure to lead for construction workers. The most significant way to achieve this is by lowering the permissible exposure limit (PEL) from 200 micrograms per cubic meter of air ($200 \mu\text{g}/\text{m}^3$) as an 8-hour time weighted average (TWA) to $50 \mu\text{g}/\text{m}^3$.

For the purpose of this standard, lead includes metallic lead, all inorganic lead compounds, and organic lead soaps. OSHA's lead in construction standard applies to all construction work where an employee may be occupationally exposed to lead. All work related to

construction, alteration, or repair, including painting and decorating, is included.

Engineering and Work Practice Controls

The lead in construction standard requires employers to use, when feasible, engineering and work practice controls to reduce and maintain employee lead exposure to or below the PEL. When all feasible controls have been instituted but are not sufficient to reduce employee exposure to or below the PEL, they must be used to reduce exposure to the lowest feasible level and supplemented by respirators.

Engineering controls reduce employee exposure in the workplace either by removing or isolating the hazard or isolating the worker from exposure through the use of technology. Under the lead in construction standard, mechanical ventilation may be used to control lead exposure. If used, the employer must evaluate, as necessary, the mechanical performance of the system in controlling exposure to maintain its effectiveness.

Work practice controls reduce the likelihood of exposure by altering the manner in which a task is performed. Safe work practices under the lead in construction standard include, but are not limited to, maintaining separate hygiene facilities (i.e., change rooms, showers, hand washing facilities, and lunch areas) and requiring proper housekeeping practices (i.e., cleanup methods).

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Worker Protection Programs

Lead has been poisoning workers for thousands of years. Traditionally, most over-exposures to lead in the construction industry have been found in the trades, such as plumbing, welding, and painting.

In building construction, lead is frequently used for roofs, cornices, tank linings, and electrical conduits. In plumbing, soft solder, used chiefly for soldering tinplate and copper pipe joints, is an alloy of lead and tin. Soft solder, in fact, has been banned for many uses in the United States. The use of lead-based paint in residential application has been banned by the Consumer Product Safety Commission. However, since lead-based paint inhibits the rusting and corrosion of iron and steel, it is still used on bridges, railways, ships, lighthouses, and other steel structures, although substitute coatings are available.

Significant lead exposures can also arise from removing paint from surfaces previously coated with lead-based paint, such as in bridge repair, residential renovation, and demolition. With the increase in highway work, including bridge repair, residential lead abatement, and residential remodeling, the potential for exposure to lead-based paint has become more common. The trades potentially exposed to lead include iron work, demolition work, painting, lead-based paint abatement work, plumbing, heating/air-conditioning, electrical work, and carpentry/renovation/remodeling.

Operations that generate lead dust and fumes include the following:

- ◆ Flame-torch cutting, welding, the use of heat guns, sanding, scraping and grinding of lead painted surfaces in repair, reconstruction, dismantling, and demolition work.

- ◆ Abrasive blasting of bridges and other structures containing lead-based paints.
- ◆ Use of torches and heat guns, and sanding, scraping, and grinding lead-based paint surfaces during remodeling or abating lead-based paint.
- ◆ Maintaining process equipment or exhaust duct work.

The employer of construction workers is responsible for the development and implementation of a worker protection program in accordance with 29 CFR 1926.20 and 29 CFR 1926.62. This program is essential in minimizing worker risk of lead exposure. Construction projects vary in their scope and potential for exposing workers to lead and other hazards. Many projects may involve limited exposure, such as the removal of paint from a few interior residential doors. Others may involve the removal, or stripping off, of substantial quantities of lead-based paints on large bridges. The employer should, as needed, consult a qualified safety and health professional¹ to develop and implement an effective worker protection program.

The most effective way to protect workers is to minimize exposure through the use of engineering controls and good work practices. It is OSHA policy that respirators are not to be used in lieu of engineering and work practice controls to reduce employee exposures to or below the PEL. Respirators can only be used in combination with engineering controls and work practices to control employee exposures. OSHA's interim final standard for lead in construction limits worker exposures to 50 micrograms of lead per cubic meter of air averaged over an eight-hour workday.

¹Sources for professional safety and health advice include insurance carriers, trade organizations, state 7(c)(1) on-site consultation programs, and consultants.

At the minimum, the following elements should be included in the employer's worker protection program for employees exposed to lead:

- ◆ Hazard determination, including exposure assessment, (see Lead-Related Tasks Regarding Interim Worker Exposure in Part 3, Table 1 in this guide)
- ◆ Engineering and work practice controls
- ◆ Respiratory protection
- ◆ Protective clothing and equipment
- ◆ Housekeeping
- ◆ Hygiene facilities and practices
- ◆ Medical surveillance and provisions for medical removal
- ◆ Training
- ◆ Signs
- ◆ Recordkeeping

To implement the worker protection program properly, the employer needs to designate a competent person (one who is capable of identifying existing and predictable hazards or working conditions that are hazardous or dangerous to employees, in accordance with the general safety and health provisions of OSHA's construction standards). The competent person must have the authorization to take prompt corrective measures to eliminate such problems. Qualified medical personnel must be available to advise the employer and employees on the health effects of employee lead exposure and supervise the medical surveillance program.

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Exposure Assessment

Assessing Exposures

Where initial employee exposure is at or above the action level ($30 \mu\text{g}/\text{m}^3$), the employer must collect personal samples representative of a full work shift, including at least one sample for each shift or for the shift with the highest exposure level for each job classification in each work area. These samples must represent the monitored employee's regular daily exposure to lead. Measurements made within the previous 12 months may be used to determine how far above the action level employee exposure may be.

An initial determination of whether employees are exposed to lead at or above the action level and the results of that determination must be made available based on the following:

- Any information, observation, or calculation that indicates employee exposure to lead.
- Any previous measurements of airborne lead.
- Any employee complaints of symptoms attributable to lead exposure.
- Objective data regarding materials, processes, or operations.

The employer may discontinue required monitoring when at least two consecutive measurements, taken at least seven days apart, are below the action level.

Monitoring for the initial determination whether employees are exposed at or above the action level may be limited to a representative sample of those employees exposed to the greatest concentrations of airborne lead.

Measurements made within the preceding 12 months, which were performed by the same employer and applicable to the same employee tasks, may be used.

The employer must establish and maintain an accurate record documenting the nature and relevancy of previous exposure data. Instead of performing initial monitoring, the employer may rely on objective data to demonstrate that a particular lead-containing material or product does not result in employee exposure at or above the action level when in use, being processed, or handled.

Until the employer performs an exposure assessment and documents that employees are not exposed above the PEL, the employer must treat employees who perform certain operations as if they were exposed above the PEL. This means that the employer must provide respiratory protection, protective work clothing and equipment, change areas, hand washing facilities, biological monitoring, and training for employees performing these “trigger” tasks. Table 1, in this section, provides a list of the lead-related tasks that require interim protection and a description of each of those operations.

For an initial determination that indicates no employee is exposed at or above the action level ($30 \mu\text{g}/\text{m}^3$), the employer must keep a written record of the determination, including the date, location within the work site, and the name and social security number of each monitored employee.

Monitoring and Observing

If the initial determination proves employee exposure is below the action level, further exposure determination need not be repeated unless there is a change in processes or controls. If employee exposure is at or above the action level, but at or below the PEL, the

employer must perform monitoring at least every six months and continue until at least two consecutive measurements, taken at least seven days apart, are below the action level.

If employee exposure is above the PEL, the employer must perform monitoring quarterly and continue until at least two consecutive measurements, taken at least seven days apart, are at or below the PEL but at or above the action level. The employer then must repeat and continue monitoring every six months to bring the exposure to or below the action level as described above.

Whenever there is a change of equipment, process, control, personnel, or a new task has been initiated that could increase employee lead exposure at or above the action level, the employer must conduct additional monitoring.

The employer must notify each employee in writing of employee exposure assessment results within five working days after their receipt. Whenever the results indicate that the representative employee exposure, without the use of respirators, is at or above the PEL, the employer must include a written notice stating that the employee's exposure was at or above that level and describing the corrective action taken or to be taken to reduce exposure below that level.

The employer must provide affected employees or their designated representatives an opportunity to observe any monitoring of employee lead exposure. This includes providing and ensuring the use of respirators and protective clothing and equipment whenever monitoring requires entry into an area where such is required. The observer is entitled to an explanation of the measurement procedures, to observe all steps related to lead monitoring performed at the place of exposure, and to record the results obtained or receive copies of the results when returned by the laboratory.

Table 1***Lead-Related Tasks Requiring Interim Worker Protection***

Abrasive blasting	Removal of scale, paint, and dirt from surfaces prior to repainting; abrasive media includes sand, steel grit, aluminum oxide, "Black Beauty" (processed boiler slag), and others.
Welding, cutting, and burning on steel structures	Process of heating coated steel to its melt temperature typically using an oxyacetylene torch or arc welder.
Lead burning	Involves torch melting or fusing of lead or alloyed lead to another lead object.
Manual scraping and sanding	Associated with lead paint removal and involves application of hand-held scraping or sanding tool to the painted surface containing lead.
Manual demolition of structure	Involves removal of walls (plaster, gypsum) or building components coated with lead-based paint that is subsequently scraped off.
Heat gun application	Use of a heat gun that produces a stream of hot air directed to surfaces to melt lead paint that is subsequently scraped off.
Using lead containing mortar	Used in high pressure acid tanks lined with specialized tile of lead brick held in place with specialized lead-containing mortar or grout; these tank linings periodically require repainting, repairing, or relining involving lead containing mortar.
Abrasive blasting enclosure movement and removal	Movement and removal of blasting enclosure or containment units as work proceeds on structures; such units are often composed of flexible nylon, plastic, or burlap tarpaulins upon which lead dust will accumulate and be retained when movement of the structure occurs.
Power tool cleaning	Use of power tools (grinders, brushes, needle guns, sanders, etc.) to remove dirt, scale, or paint from structures where lead-based paint is present.
Rivet busting	Removal of rivets from steel structures where lead-containing paints are present; rivet busting can involve use of torches and mechanical means for rivet extraction.
Cleanup activities where dry expendable abrasives are used	Use of non-recycled dry abrasives during abrasive blasting operations on structures where lead-containing paint is found.

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Engineering Controls

Lead is a cumulative and persistent toxic substance. Lead-caused health effects may result from low levels of exposure over prolonged periods of time. Engineering controls and good work practices must be used where feasible to minimize employee exposure to lead. At a minimum, exposures must not exceed the OSHA interim final PEL of 50 micrograms per cubic meter of air ($50 \mu\text{g}/\text{m}^3$) averaged over an 8-hour period. When feasible engineering controls and work practice controls cannot reduce worker exposure to lead at or below $50 \mu\text{g}/\text{m}^3$, respirators must be used to supplement engineering and work practice controls.

A competent person² should review all site operations and stipulate the specific engineering controls and work practices designed to reduce worker exposure to lead. Engineering measures include local and general exhaust ventilation, process and equipment modification, material substitution, component replacement, and isolation or automation. Examples of recommended engineering controls that can be used to reduce worker exposure to lead are as follows:

Exhaust Ventilation

Power tools used for the removal of lead-based paint should be equipped with dust collection shrouds or other attachments exhausted through a high-efficiency particulate air (HEPA) vacuum system. Operations such as welding, cutting/burning, or heating should be

²One 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.

provided with local exhaust ventilation. HEPA vacuums should be used during cleanup activities.

For abrasive blasting operations where full containment exists or is required, the containment structure should be designed to optimize the flow of ventilation air past the worker(s), so that the airborne concentration of lead is reduced and the visibility is increased. The affected area should be maintained under negative pressure to reduce the chances that lead dust will contaminate areas outside the enclosure. A containment structure should be equipped with dust collection and an air-cleaning device to control emissions of particulate matter to the environment.

Enclosure/Encapsulation

Lead-based paint can be made inaccessible either by encapsulating it with a material that bonds to the surface, such as acrylic or epoxy coating or flexible wall coverings, or by enclosing it using systems such as gypsum wallboard, plywood paneling, and aluminum, vinyl or wood exterior siding. Floors coated with lead-based paint can be covered using vinyl tile or linoleum flooring.

The building owner, or other responsible person, should oversee the custodial and maintenance staffs and contractors with regard to all activities that involve enclosed or encapsulated lead-based paint. This will minimize potential inadvertent release of lead during maintenance, renovation, or demolition.

Substitution

Zinc-containing primers covered by an epoxy intermediate coat and polyurethane topcoat are commonly used instead of lead-containing coatings.

Mobile hydraulic shears can be substituted for torch cutting under certain circumstances.

Surface preparation equipment, such as needle guns with multiple reciprocating needles completely enclosed within an adjustable shroud, can be substituted for abrasive blasting under certain operations. The shroud captures dust and debris at the cutting edge and can be equipped with a HEPA vacuum filtration system with a self-drumming feature. One such commercial unit can remove lead-based paint from flat steel and concrete surfaces, outside edges, inside corners, and pipes.

Chemical strippers, used primarily on the exterior of buildings, surfaces involving carvings or molding, or intricate iron works, can be used in place of hand scraping using a heat gun. Chemical removal generates less airborne lead dust; however, these strippers can be hazardous. The material safety data sheets (MSDSs) for the products used must be reviewed by the employer for information on worker exposure hazards from the chemical ingredients and protective measures recommended by the manufacturer.

Component Replacement

Lead-base painted building components (i.e., windows, doors, and trim) can be replaced either with new components free of lead-containing paint or with the same components after the paint has been removed off-site. Replacement is a permanent solution.

Process/Equipment Modification

Brush/roller application of lead paints or other lead-containing coatings is a safer method than spraying. This method of application introduces little or no paint mist into the air where the mist can present a lead inhalation hazard. (Note: There is a ban on the use of lead-based paint in residential housing.)

Non-silica containing abrasive (e.g., steel or iron shot/grit) should be used, where practical, instead of

sand in abrasive blasting operations. When sand is used, the free silica portion of the dust presents a significant respiratory health hazard.

Blasting techniques that are less dusty than abrasive blasting and that can be effective under some conditions include: (1) hydro- or wet-blasting (using high-pressure water with or without abrasive, or surrounding the blast nozzle with a ring of water) and (2) vacuum blasting where a vacuum hood for material removal is positioned around the exterior of the blasting nozzle.

Heat guns used to remove lead-based paints in residential housing units should be of the flameless electrical softener type. Heat guns should have electronically controlled temperature settings to allow usage below 700 degrees F. Heat guns should be equipped with various nozzles to cover all common applications and to limit the heated work area.

When using abrasive blasting with vacuum hood on exterior building surfaces, care should be taken that the configuration of the heads on the blasting nozzle match the configuration of the substrate, so that the vacuum is effective in containing debris.

Since HEPA vacuum cleaners can be used to clean surfaces other than just floors, operators should have attachments appropriate for use on unusual surfaces. The proper use of brushes of various sizes and crevice and angular tools, when needed, will enhance the quality of the HEPA-vacuuming process and help reduce the amount of lead dust released into the air.

Isolation

Although it is not feasible to completely enclose and ventilate some abrasive blasting operations, it is possible to isolate many operations to help reduce the potential for exposure to lead. Isolation, in this instance, consists of keeping employees not involved

in the blasting operations as far away as possible from the work area. By placing the employees a greater distance from the source of lead exposure, their exposures will be reduced.

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Housekeeping and Personal Hygiene Practices

Lead is a cumulative and persistent toxic substance that poses a serious health risk. A rigorous housekeeping program and adherence to basic personal hygiene practices will minimize employee exposure to lead. In addition, these two elements of the worker protection program will help to prevent taking lead-contaminated dust out of the worksite and home to the workers' families, thus ensuring that the duration of lead exposure does not extend beyond the workshift and providing added protection to employees and their families.

Housekeeping

An effective housekeeping program involves at least daily removal of accumulations of lead dust and lead-containing debris. Vacuuming lead dust with high-efficiency particulate air (HEPA) filtered equipment or wetting it with water before sweeping are effective control measures. Such cleaning operations should be conducted, whenever possible, at the end of the day, after normal operations cease. Furthermore, all persons doing the cleanup should be provided with suitable respiratory protection and personal protective clothing to prevent contact with lead.

In addition, all lead-containing debris and contaminated items accumulated for disposal should be collected and put into sealed impermeable bags or other closed impermeable containers. Bags and containers should be appropriately labeled as lead-containing waste. These measures are especially important as they minimize additional sources of exposure that engineering

controls generally are not designed to control. Disposal of lead-containing waste should be done in accordance with federal, state, and local government regulations.

Personal Hygiene Practices

To minimize exposure to lead, special attention should be given to workers' personal hygiene. The employer must provide and ensure that workers use washing facilities. Clean change areas and separate noncontaminated eating areas must also be provided. Cars should be parked where they will not be contaminated with lead. These measures will reduce the worker's period of exposure to lead and the ingestion of lead, ensure that the duration of lead exposure does not extend beyond the workshift, significantly reduce the movement of lead from the worksite, and provide added protection to employees and their families.

Change areas: The employer must provide a clean change area for employees exposed above the permissible exposure limit or who are performing certain "trigger" tasks. (See Table 1 in Part 3 of this guide.) The change area must be equipped with storage facilities for street clothes and a separate area with facilities for the removal and storage of lead-contaminated protective work clothing and equipment. This separation is essential in preventing cross contamination of the employee's clothing.

Clean change areas are to be used for taking off street clothes, suiting up in clean working clothes (protective clothing), donning respirators prior to beginning work, and dressing in street clothes after work. No lead-contaminated items should enter this area.

Work clothing must not be worn away from the job site. Under no circumstances should lead-contaminated work clothes be laundered at home or taken from the

worksite, except to be laundered professionally or properly disposed of following applicable federal, state, and local regulations.

Showers: When there is potential for extensive contamination of the employees' skin, hair, and protective clothing, shower facilities must be provided, if feasible, so that exposed employees can wash lead from their skin and hair prior to leaving the worksite. Where showers are provided, employees must change out of their work clothes and shower before changing into their street clothes and leaving the worksite.

Workers who do not change into clean clothing before leaving the worksite may contaminate their homes and automobiles with lead dust. Other members of the household may then be exposed to harmful amounts of lead.

Personal practices (eating, drinking, etc.): The employer must ensure that employees who work with lead either clean or remove their protective clothing and wash their hands and face prior to eating, drinking, smoking, or applying cosmetics. These latter practices are never permitted while in the work area or in areas subject to the accumulation of lead. HEPA vacuuming can be used to remove loose contamination from the work clothing prior to eating.

Washing facilities: Adequate washing facilities must be provided for employees. Such facilities must be in near proximity to the worksite and provided with water, soap, and clean towels to enable employees to remove lead contamination from their skin.

Contaminated water from washing facilities and showers must be disposed of in accordance with applicable local, state, or federal regulations.

End-of-day procedures: Workers who are exposed to lead should follow these procedures upon finishing work for the day:

- ◆ Place disposable coveralls and shoe covers into containers designated for lead waste.
- ◆ Place lead-contaminated clothes, including work shoes, and personal protective equipment for laundering/cleaning (by the employer) in a closed container.
- ◆ Take a shower and wash hair.
- ◆ Change into street clothes.

6

Protective Clothing

At no cost to employees, employers must provide workers who are exposed to lead above the PEL and for whom the possibility of skin contamination or skin or eye irritation exists, clean, dry protective work clothing and equipment. Appropriate changing facilities must also be provided. Appropriate protective work clothing and equipment used on construction sites can include:

- Coveralls or other full-body work clothing
- Gloves
- Vented goggles or face shields with protective spectacles or goggles
- Welding or blasting helmets, when required

Disposable coveralls and separate shoe covers may be used, if appropriate, to avoid the need for laundering. Nondisposable coveralls must be replaced daily. If an employee leaves the work area wearing protective clothing, the clothing should be cleaned with high-efficiency particulate air (HEPA) filter vacuum equipment to remove loose particle contamination; or as an alternative, the coveralls should be removed. Before respirators are removed, HEPA vacuuming or other suitable method, such as damp wiping, shall be used to remove loose particle contamination on the respirator and at the face-mask seal. Use work garments of appropriate size, and use duct tape to reinforce their seams (e.g., under-arm, crotch, and back).

Contaminated clothing that is to be cleaned, laundered, or disposed of must be placed in closed containers. Containers must be labeled with the following warning:

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.

Persons responsible for handling contaminated clothing must be informed of the potential hazard in writing. At no time should lead be removed from protective clothing or equipment by any means that disperses lead into the work area, such as brushing, shaking, or blowing.

At no time should workers be allowed to leave the worksite wearing lead-contaminated clothing or equipment, (e.g., shoes, coveralls, or head gear). All contaminated clothing and equipment must be prevented from reaching the worker's home or vehicle. This is an essential step in reducing the movement of lead contamination from the workplace into a worker's home and provides added protection to employees and their families.

Gloves and protective clothing should be appropriate for the specific chemical exposure (e.g., solvents and caustics). Cotton gloves provide some protection against the contamination of hands and cuticles with lead dust. Workers should wear clothing that is appropriate for existing weather and temperature conditions under the protective clothing.

Heat Stress

Workers wearing protective clothing can face a risk from heat stress. Additionally, heat stress may be an important concern when working in a hot environment or within containment structures. Heat stress is caused by a number of interacting factors, including: environmental conditions, type of protective clothing worn, the work activity required, and the individual characteristics of the employee.

In situations where heat stress is a concern, employers should use appropriate work/rest regimens and provide heat stress monitoring that includes measuring employees' heart rates, body temperatures, and weight loss.

A source of water or electrolytic drink should be close to the work area (in a noncontaminated eating/drinking area) so that it will be used often. Workers should wash their hands and face prior to drinking any fluid. Frequent fluid intake throughout the day will replace body fluids lost to evaporation. If such measures are used to control heat stress, protective clothing can be safely worn to provide the needed protection against lead exposure. The possibility of heat stress and its signs and symptoms should be discussed with all workers.

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Respiratory Protection

Although engineering and work practice controls are the primary means of protecting workers, source control at construction sites is often not sufficient to control exposure, and airborne lead concentrations may be high or vary widely. In the construction industry, respirators must be used at times to supplement engineering controls and work practices whenever these controls are technologically incapable of reducing worker exposures to lead to $50 \mu\text{g}/\text{m}^3$ or below.

To provide adequate respiratory protection, respirators must be donned before entering the work area and should not be removed until the worker has left the area, or as part of a decontamination procedure.

Respiratory Protection Program

When respirators are provided, the employer must establish a respiratory protection program in accordance with the OSHA standards on lead in construction (interim) respirator protection, 29 CFR 1926.62(f)(4) and 29 CFR 1910.134. Minimum requirements for an acceptable respirator program for lead include the following elements:

- ◆ Written standard operating procedures governing the selection and use of respirators.
- ◆ Selection of respirators on the basis of hazards to which the worker is exposed.
- ◆ Instruction and training in the proper use of respirators and their limitations.
- ◆ Regular inspection and cleaning, maintenance, and disinfection. (Worn or deteriorated parts must be replaced, including replacement of the filter)

element in an air-purifying respirator whenever an increase in breathing resistance is detected.)

- ❖ Storage in a convenient, clean, and sanitary location with protection against sunlight and physical damage.
- ❖ Appropriate surveillance of work area conditions and degree of worker exposure or stress (physiological or psychological) must be maintained.
- ❖ Evaluation to determine the continued effectiveness of the program.
- ❖ Physician's determination that the employee is physically able to perform the work and wear a respirator while performing the work. (Respirator user's medical capacity to wear and work with a respirator should be reviewed annually.)
- ❖ Use of Mine Safety and Health Administration/ National Institute for Occupational Safety and Health (MSHA/NIOSH) certified respirators.
- ❖ Fit testing of negative-pressure respirators.
- ❖ Breathing air used for supplied-air respirators must meet the requirements prescribed in 29 CFR 1910.134(b), (d), (e), and (f).
- ❖ Standing permission for employees to leave the work area to wash their faces and respirator face pieces whenever necessary to prevent skin irritation associated with respirator use.

Respirator Selection

Lead concentrations may vary substantially throughout a work shift as well as from day to day. The highest anticipated work concentration is to be used in the initial selection of an appropriate respirator. The employer must provide respiratory protection, at no cost to the employee, and must ensure its proper use in the following circumstances:

- ◆ During the time period necessary to install and implement engineering or work practice controls.
- ◆ Engineering and work practice controls that can be instituted are not sufficient to reduce employee exposure to or below the permissible exposure limit (PEL).
- ◆ Whenever an employee requests a respirator.

An appropriate respirator, which has been approved by the Mine Safety and Health Administration (MSHA) and NIOSH, must be selected to protect against lead dust, fumes, and mists. (See Table 2, in this section, for recommended respiratory protection.)

Respirators issued to employees must exhibit minimum facepiece leakage and fit the employee properly. Employers must perform either quantitative or qualitative (for half-mask respirators only) face fit tests at the time of initial fitting and at least every six months for each employee wearing a negative-pressure respirator. If the employee shows signs of breathing difficulty during the fit test or during use, the employer must make an examination available in accordance with the medical surveillance requirements of the standard.

Employees who use filter respirators must be permitted to change the filter elements whenever an increase in breathing resistance is detected. They must be allowed to leave work areas to wash their faces and respirator facepieces whenever necessary to prevent skin irritation associated with respirator use.

Table 2
Respiratory Protection for Lead Aerosols

Airborne Concentration of Lead or Condition of Use	Required Respirator*
Not in excess of 500 µg/m ³ (10 X PEL)	Half-mask air-purifying respirator with high-efficiency filters.†# Half-mask supplied-air respirator operated in demand (negative-pressure) mode.
Not in excess of 1,250 µg/m ³ (25 X PEL)	Loose fitting hood or helmet powered air-purifying respirator with high-efficiency filters.# Hoods or helmet supplied-air respirator operated in continuous-flow mode—for example, type CE abrasive blasting respirators operated in a continuous-flow mode.
Not in excess of 2,500 µg/m ³ (50 X PEL)	Full-facepiece air-purifying respirator with high-efficiency filters.# Tight-fitting powered air-purifying respirator with high-efficiency filters.# Full-facepiece supplied-air respirator operated in demand mode. Half-mask or full-facepiece supplied-air respirator operated in continuous-flow mode. Full-facepiece self-contained breathing apparatus (SCBA) operated in demand mode.
Not in excess of 50,000 µg/m ³ (1,000 X PEL)	Half-mask supplied-air respirator operated in pressure-demand or other positive-pressure mode.
Not in excess of 100,000 µg/m ³ (2,000 X PEL)	Full-facepiece supplied-air respirator operated in pressure-demand or other positive-pressure mode—for example, type CE abrasive blasting respirators operated in a positive-pressure mode.
Greater than 100,000 µg/m ³ , unknown concentration, or firefighting	Full-facepiece SCBA operated in pressure-demand or other positive-pressure mode.

Source: "Lead Exposure in Construction; Interim Final Rule," *Federal Register* 58(84):26630, May 4, 1993.

*Respirators specified for higher concentrations can be used at lower concentrations of lead.

†Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

#A high-efficiency particulate air filter means a filter that is 99.97 percent efficient against particles of 0.3 micron or larger.

If exposure monitoring or experience indicates airborne exposures to contaminants other than lead, such as solvents or polyurethane coatings, these exposures must be considered when selecting respiratory protection. A reevaluation of the respiratory protection program is required when a worker demonstrates a continued increase in blood lead levels.

Abrasive Blasting and Related Operations

NIOSH type CE respirators are required for use by abrasive blasting operators. Currently, NIOSH certifies both continuous flow and positive pressure respirators for abrasive blasting operations. The continuous flow respirators are recommended by NIOSH only for airborne concentrations less than or equal to 25 times³ the OSHA PEL of 50 µg/m³. Positive pressure respirators are recommended by NIOSH for airborne concentrations less than 2,000 times the OSHA PEL of 50 µg/m³. Furthermore, manufacturer's instructions regarding quality of air, air pressure, inside diameter of hoses, and length of hoses must be strictly followed. Use of longer hoses or smaller inside diameter hoses than the manufacturer's specifications or hoses with bends or kinks may restrict the flow of air to a respirator.

³Type CE continuous flow respirators used in abrasive blasting that are manufactured by E.D. Bullard Company (Models 77 and 88) and CLEMCO Industries Corporation (Apollo 20 and Apollo 60) are acceptable in atmospheres where the airborne level does not exceed 50,000 µg/m³ (1,000 times the PEL) of lead in air. The relief for these two models applies only to *lead in construction*. The Assigned Protection Factor (APF) of 1,000 does not apply to other air contaminants. Therefore, if silica sand is used as the blasting agent, the APF reverts back to 25 times the PEL (1,250 µg/m³).

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Medical Assessment and Recordkeeping

When a construction employee is occupationally exposed to lead at or above the action level of $30 \mu\text{g}/\text{m}^3$ on any one day in a calendar year, the employee must be provided initial medical surveillance consisting of biological monitoring in the form of blood sampling and analysis for lead and zinc protoporphyrin levels. Blood lead levels are currently the best indicator of personal lead exposure. Workers potentially exposed to lead at or above the action level must be monitored for the presence of lead in the blood and the effects of lead on the blood-forming system. Full medical surveillance is to be provided to employees exposed to lead at or above the action level for more than 30 days per year. All medical examinations and consultations must be performed by or under the direct supervision of a qualified physician and must be provided to employees at no cost, without loss of pay, and at a reasonable time and place. A qualified physician is a doctor of medicine (M.D.) or osteopathy (D.O.) familiar with the objectives and requirements of a medical surveillance program for lead exposure.

The following conditions necessitate an immediate medical consultation including, as determined by the qualified physician, a physical examination and a blood sample for lead analysis (biological monitoring):

- Whenever a worker develops signs or symptoms associated with lead toxicity.
- Before a worker restarts work following medical removal.

The employer must maintain any employee exposure and medical records to document ongoing employee exposure, medical monitoring, and medical removal of workers. These data provide a base to properly evaluate the employee's health. In addition, employees or former employees, their designated representatives, and OSHA must be provided access to exposure and medical records.

Biological Monitoring

The purpose of biological monitoring is to identify workers with elevated blood lead levels. The data from biological monitoring are objective evidence of a worker's body burden from lead exposure. These data can be used to follow changes in worker exposure. Blood lead and zinc protoporphyrin (ZPP) or free erythrocyte protoporphyrin (FEP) must be monitored for those workers exposed to lead. In general, workers in high-risk occupations should be monitored as often as needed to prevent adverse health effects.

Reproductive Hazard Issues

Lead is toxic to both male and female reproductive systems. Workers who are actively seeking to have a child or who are pregnant should contact qualified medical personnel to arrange for a job evaluation and medical follow-up. Employers who have been contacted by employees with concerns about reproductive issues should refer them to qualified medical personnel.

Medical Surveillance

The employer must institute a medical surveillance program for all employees who are or may be exposed above the action level for more than 30 days per year. The employer must maintain an accurate record for each employee subject to medical surveillance to include

a description of the employee's duties; a copy of the physician's written opinions; the results (as supplied to the examining physician) of any airborne exposure monitoring done for the representative employee and all others represented; and any employee medical complaints related to lead exposure.

The employer must obtain and furnish to the employee the physician's written opinion. This opinion should contain the results of the medical examination as they relate to occupational exposure to lead and must include:

- Whether the employee has any detected medical condition that would place his/her health at increased risk from lead exposure.
- Any special protective measures or limitations on worker's exposure to lead.
- Any limitation on respirator use.
- Results of blood lead determination.
- A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

Findings of lab results or diagnoses unrelated to the worker's exposure to lead must not be communicated to the employer or included in a written opinion. Employees should be advised by each physician of any medical condition, occupational or nonoccupational, that necessitates further medical evaluation or treatment. The employer must furnish the employee with a copy of the written medical opinion.

In addition, the employer must keep or ensure that the examining physician keeps the following medical records: a copy of the medical examination results

including medical and work history; a description of the laboratory procedures and a copy of any guidelines used to interpret the test results; and a copy of the results of biological monitoring.

Chelation

The use of chelating drugs as a prophylactic measure (i.e., to prevent a detectable rise in blood lead) is an unacceptable medical practice. Chelation may be used by a qualified physician only for diagnostic or therapeutic reasons (that is, to diagnose or treat the signs and symptoms of severe lead toxicity).

Medical Removal

Medical removal will protect worker health both by stopping further occupational exposure and by enabling the worker to excrete the absorbed lead naturally. With good engineering, work practices, personal hygiene, and respiratory protection practices in place, very few employees should reach the medical removal trigger level specified in the OSHA standard. OSHA's interim final standard for lead in construction uses a medical removal trigger level of 50 $\mu\text{g}/\text{dl}$. However, some authorities believe that medical removal should take place at lower levels.

When employees are removed, or otherwise limited, they must be placed in jobs that will not result in exposure to lead at or above the action level of 30 $\mu\text{g}/\text{m}^3$. The employer may return the employee to his or her former job status when a qualified physician's medical determination is that the employee is no longer at risk from exposure to lead or when the employee's blood lead level drops below 40 $\mu\text{g}/\text{dl}$.

In the case of medical removal, records must include the following information:

- The name and social security number of the worker.
- The date of each occasion that the worker was removed from current exposure to lead.
- The date on which the worker was returned to his or her former job status.
- A brief explanation of how each removal was or is being accomplished.
- A statement indicating whether the reason for the removal was an elevated blood lead level.

The employer must maintain these records for at least the duration of any worker's employment.

Recordkeeping

The employer must establish and maintain an accurate record of all monitoring and other data used to conduct employee exposure assessments in accordance with provisions in 29 CFR 1926.62(n). The following must be included in exposure monitoring records:

- The dates, number, duration, location, and results of each sample taken, including a description of the sampling procedure used to determine representative employee exposure.
- A description of the sampling and analytical methods used and evidence of their accuracy.
- The type of respiratory protection worn, if any.
- The name, social security number, and job classification of the monitored employee and all others whose exposure the measurement represents.
- Environmental variables that could affect the measurement of employee exposure.

Employers must properly record cases on their OSHA form 200 when the worker:

- Has a blood lead level that exceeds 50 µg/dl.
- Has symptoms of lead poisoning, such as colic, nerve damage, renal damage, anemia, or gum problems.
- Receives medical treatment to lower blood lead levels or for lead poisoning.

In addition, employees or former employees, their designated representatives, and OSHNC must be provided access to exposure and medical records in accordance with 29 CFR 1910.20. When an employer ceases to do business, the successor employer must receive and retain all required records.

The following industry guides are available from the N.C. Department of Labor's Division of Occupational Safety and Health:

- #1. A Guide to Safety in Confined Spaces*
- #2. A Guide to Procedures of the Safety and Health Review Board of North Carolina*
- #3. A Guide to Machine Safeguarding*
- #4. A Guide to OSHA in North Carolina*
- #5. A Guide for Persons Employed in Cotton Dust Environments*
- #6. A Guide to Lead Exposure in the Construction Industry*
- #7. A Guide to Bloodborne Pathogens in the Workplace*
- #8. A Guide to Voluntary Training and Training Requirements in OSHA Standards*
- #9. A Guide to Ergonomics*
- #10. A Guide to Farm Safety and Health*
- #11. A Guide to Radio Frequency Hazards With Electric Detonators*
- #12. A Guide to Forklift Operator Training*
- #13. A Guide to the Safe Storage of Explosive Materials*
- #14. A Guide to the OSHA Excavations Standard*
- #15. A Guide to Developing and Maintaining an Effective Hearing Conservation Program*
- #17. A Guide to Asbestos for Industry*
- #18. A Guide to Electrical Safety*
- #19. A Guide to Occupational Exposure to Wood and Wood Dust*
- #20. A Guide to Crane Safety*
- #21. A Guide to School Safety and Health*
- #23. A Guide to Working With Electricity*
- #25. A Guide to Personal Protective Equipment*
- #26. A Guide to Manual Materials Handling and Back Safety*
- #27. A Guide to the Control of Hazardous Energy (Lockout/Tagout)*
- #28. A Guide to Eye Wash and Safety Shower Facilities*
- #29. A Guide to Safety and Health in Feed and Grain Mills*
- #30. A Guide to Working With Corrosive Substances*
- #31. A Guide to Formaldehyde*
- #32. A Guide to Fall Prevention in Industry*
- #33. A Guide to Office Safety and Health*
- #34. A Guide to Safety and Health in the Poultry Industry*
- #35. A Guide to Preventing Heat Stress*
- #36. A Guide to the Safe Use of Escalators and Elevators*
- #37. A Guide to Boilers and Pressure Vessels*
- #38. A Guide to Safe Scaffolding*
- #39. A Guide to Safety in the Textile Industry*
- #40. A Guide to Emergency Action Planning*
- #41. A Guide to OSHA for Small Businesses in North Carolina*

Occupational Safety and Health (OSH) Sources of Information

You may call 1-800-NC-LABOR to reach any division of the N.C. Department of Labor; or visit the NCDOL home page on the World Wide Web, Internet Web site address: <http://www.nclabor.com>.

N.C. Division of Occupational Safety and Health

Mailing Address:	Physical Location:
4 W. Edenton St.	111 Hillsborough St.
Raleigh, NC 27601-1092	(Old Revenue Building, 3rd Floor)
Local Telephone: (919) 807-2900	Fax: (919) 807-2856

For information concerning education, training and interpretations of occupational safety and health standards contact:

Bureau of Education, Training and Technical Assistance

Mailing Address:	Physical Location:
4 W. Edenton St.	111 Hillsborough St.
Raleigh, NC 27601-1092	(Old Revenue Building, 4th Floor)
Telephone: (919) 807-2875	Fax: (919) 807-2876

For information concerning occupational safety and health consultative services and safety awards programs contact:

Bureau of Consultative Services

Mailing Address:	Physical Location:
4 W. Edenton St.	111 Hillsborough St.
Raleigh, NC 27601-1092	(Old Revenue Building, 3rd Floor)
Telephone: (919) 807-2899	Fax: (919) 807-2902

For information concerning migrant housing inspections and other related activities contact:

Agricultural Safety and Health Bureau

Mailing Address:	Physical Location:
4 W. Edenton St.	111 Hillsborough St.
Raleigh, NC 27601-1092	(Old Revenue Building, 2nd Floor)
Telephone: (919) 807-2923	Fax: (919) 807-2924

For information concerning occupational safety and health compliance contact:

Safety and Health Compliance District Offices

Raleigh District Office

Telephone: Safety (919) 662-4597	Fax: (919) 662-4709
Health (919) 662-4711	

Charlotte District Office

(901 Blairhill Road, Suite 200, Charlotte, NC 28217-1578)
Telephone: Safety (704) 342-6163 Fax: (704) 342-5919

Winston-Salem District Office

(901 Peters Creek Parkway, Winston-Salem, NC 27103-4551)
Telephone: Safety (336) 761-2700 Fax: (336) 761-2326
Health (336) 761-2700 Fax: (336) 761-2130

Wilmington District Office

(1200 N. 23rd St., Suite 205, Wilmington, NC 28405-1824)
Telephone: (910) 251-2678 Fax: (910) 251-2654

Asheville District Office

(204 Charlotte Highway, Suite B, Asheville, NC 28803-8681)
Telephone: (828) 299-8232 Fax: (828) 299-8266

*****To make an OSHA Complaint, OSH Complaint Desk: (919) 807-2796*****

For statistical information concerning program activities contact:

Planning, Statistics and Information Management

Mailing Address:	Physical Location:
4 W. Edenton St.	111 Hillsborough St.
Raleigh, NC 27601-1092	(Old Revenue Building, 2nd Floor)
Telephone: (919) 807-2950	Fax: (919) 807-2951

For information about books, periodicals, vertical files, videos, films, audio/slide sets and computer databases contact:

N.C. Department of Labor Library

Mailing Address:	Physical Location:
4 W. Edenton St.	111 Hillsborough St.
Raleigh, NC 27601-1092	(Old Revenue Building, 5th Floor)
Telephone: (919) 807-2848	Fax: (919) 807-2849

N.C. Department of Labor (Other than OSH)

4 W. Edenton St.
Raleigh, NC 27601-1092
Telephone: (919) 733-7166 Fax: (919) 733-6197