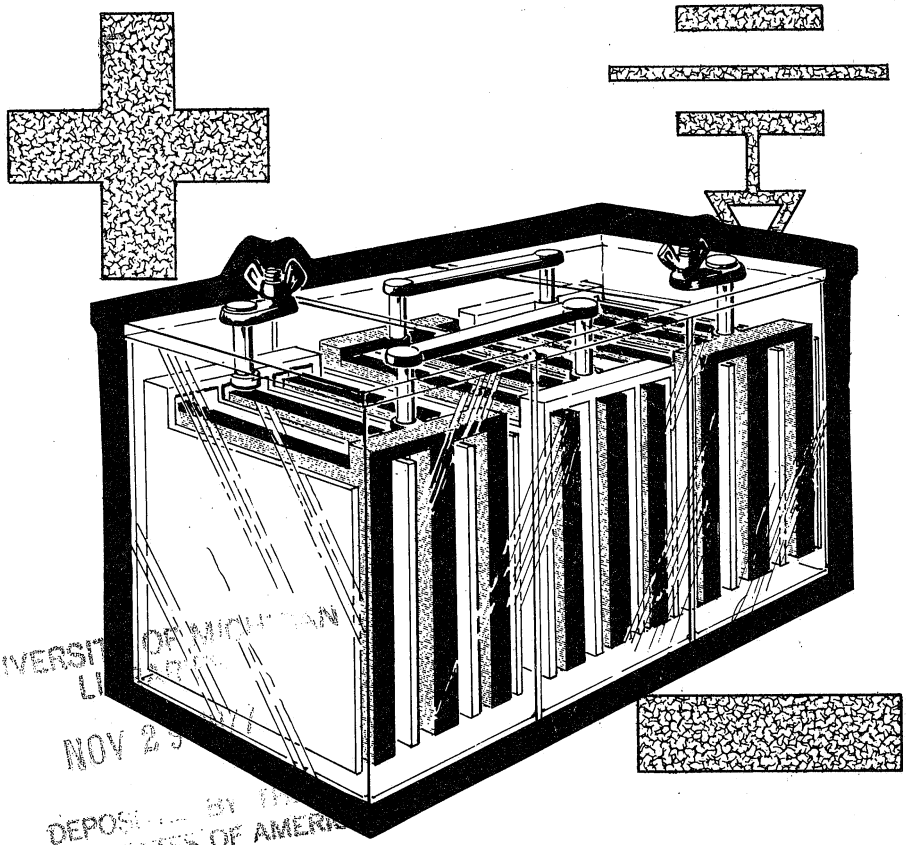
NIOSH

HEALTH and SAFETY GUIDE for STORAGE BATTERY MANUFACTURERS



U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

NIOSH HEALTH AND SAFETY GUIDES

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Division of Technical Services
Cincinnati, Ohio

July 1977

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

ACKNOWLEDGEMENT

This booklet was prepared by the NIOSH Technical Information Development Branch in the Division of Technical Services, and personnel in the Regional Offices, who gathered information from state and federal agencies, trade associations, insurance companies, and through in-plant visits. Those contributing to the development of the Health and Safety Guide for Storage Battery Manufacturers were Gerald J. Karches, Chief, Technical Information Development Branch (TIDB); Thomas F. Bloom, Industrial Hygienist, TIDB; Ray Hervin, Industrial Hygienist, Region VII; and Irv Kingsley, Industrial Hygienist, Region II.

DHEW (NIOSH) Publication No. 77-190

CONTENTS

INTRODUCTION

The Williams-Steiger "Occupational Safety and Health Act of 1970" was passed into law "to assure safe and healthful working conditions for working men and women . . ." This Act established the National Institute for Occupational Safety and Health (NIOSH) in the Department of Health, Education, and Welfare (DHEW) and the Occupational Safety and Health Administration (OSHA) in the Department of Labor (DOL). The Act provides for research, informational programs, education, and training in the field of occupational safety and health and authorizes the enforcement of standards. As part of these activities, surveys have been made by NIOSH to determine the most common health and safety problems in small businesses. This Guide was developed for manufacturers of lead-acid and alkaline storage batteries.

While the aim of this Guide is to assist in providing a safe and healthful workplace by describing both safe practices and some of the more frequently encountered violations of the safety and health standards, it is not intended to provide total information in all areas of compliance. Additional information can be found in the General Industry Standards (Code of Federal Regulations, Title 29, Part 1910 — Occupational Safety and Health Standards).

Words such as "must", "shall", "required", and "necessary" appearing in the text indicate requirements under the Federal Regulations. Procedures indicated by "should" and "suggested" constitute generally accepted good practices.

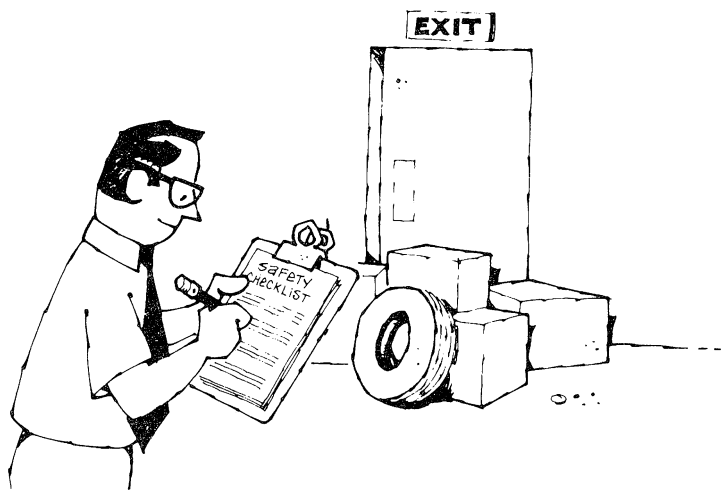
In some states, the federal government has delegated enforcement authority for occupational safety and health to the state government. Although state standards sometimes differ from federal standards, they must be at least as effective as the federal standards.

On the last few pages of the Guide are listed addresses of NIOSH and OSHA regional offices where additional information and materials can be obtained. Consultation resulting from requests for assistance will not result in a compliance visit by OSHA.

HEALTH AND SAFETY GUIDELINES

health and safety program

A valuable aid to the employer in the identification of health and safety hazards is the establishment of a health and safety program. Hazards may be identified by performing inspections, interviewing employees for suggestions and complaints, promptly investigating accidents, reviewing injury and illness records, and using material from this Guide and other sources.



Management may assign certain safety and health responsibilities in the development of a health and safety program. Health and safety hazards, corrective procedures, and injury and illness records can be discussed in regular or informal meetings. To ensure program success, management leadership and support are necessary. Those assigned responsibility for the program must have the authority to carry it out. Everyone in your establishment should be made aware of the program, because well-informed employees will very likely show interest and a desire to participate.

General Philosophy for Health and Safety Compliance

A thorough analysis of the workplace for health and safety hazards may reveal unsafe acts or conditions. Many conditions are covered by specific standards. For those hazardous conditions or practices which arise during the manufacture of storage batteries and are **not** covered by specific OSHA standards, the general duty clause of the Act applies. This clause states that "Each employer shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees." It is important in all cases to eliminate these "recognized hazards".

During the analysis for standards compliance, it may become apparent that the letter of the law is not being met. This may be particularly noticeable where dimensions are given for ladders, stairs, railings, etc. If it is apparent that the intent of the law is being met, a variance from the applicable standard may be requested from OSHA, instead of making changes. The decision not to make changes should only be made with the concurrence of OSHA.

When a citation is issued, it is important for the employer to have demonstrated a willingness to comply with the law by operating a safety and health program, correcting hazards in the workplace, and maintaining records of purchases, installations, and other activities promoting compliance.

Employee Training

An important part of a health and safety program is employee training. Although training needs may differ with the type of battery manufactured, these suggestions for training apply to both lead-acid and alkaline battery manufacture:

Employees should know the need for constant attention to their working environment, even during automatically controlled operations.

Employees should know how hazardous substances which they encounter enter the body. Substances may be absorbed through the skin, inhaled, or ingested. **Employees should know the symptoms of overexposure to these hazardous substances**—particularly lead, nickel, cadmium, and mercury.

Instruct employees in the proper handling, storing, mixing, and disposal of hazardous substances. In many cases, this information is available from the manufacturer's Material Safety Data Sheet.

Train employees in emergency procedures in case of lead or chemical spills. This instruction should include decontamination procedures.

Train employees in the proper use of protective equipment for each chemical formulation, preparation, and process and particularly the use of respirators for lead fumes and dust. (See "Personal Protective Equipment".)

Train employees in good personal hygiene. For manufacturers of storage batteries, particularly lead-acid batteries, the practices should include, as a minimum, a shower at the end of each work shift; washing hands and face before eating, drinking, or smoking; no eating, drinking, or smoking outside of designated areas; and a daily change of work clothing.

Be sure all employees have a list of standard operating procedures and are familiar with these procedures.

Promote "good housekeeping". It can reduce accidents and fire hazards, and develop in employees a sense of pride in their surroundings. All employees should take part in the clean-up. They should know the hazards involved and proper clean-up procedures.

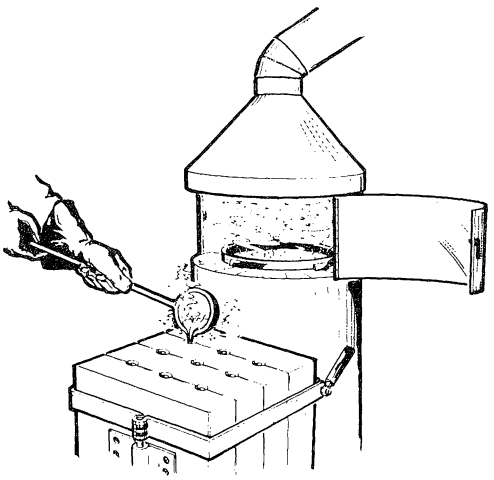
Train employees in the use of forklifts, cranes, trucks, and other powered equipment. This should include safety precautions, signals, etc.

Instruct employees in the use of portable fire extinguishers. (Refer to the fold-out chart in this booklet.) Post the telephone numbers of the local fire department. Also, develop emergency procedures in case of fire.

Provide first aid training for at least one worker on each shift. Any approved course (American Red Cross, Bureau of Mines, etc.) is acceptable.

Instruct employees in safe lifting. An easily understood chart, "How to Lift Safely", is included in the back of this book.

general information on manufacturers of storage batteries



The storage battery industry is made up of those manufacturers of batteries which can be restored (recharged) to their original output. Storage batteries are of two types: the lead-acid cell battery, which has lead plates as the electrode and a sulfuric acid solution as the electrolyte, and the alkaline cell battery which is made up of two metals—such as nickel and cadmium—with a basic electrolyte, usually a mixture of potassium hydroxide and lithium hydroxide. Lead-acid batteries make up most of the storage battery market, with the best-known use being in the automobile. However, with an emphasis by consumer and manufacturer on space, weight, and cost, the alkaline storage battery is finding increased use, with notable applications in hearing aids, watches, radios, and cameras.

In collecting information for this guide, current reports from the Bureau of Labor Statistics (BLS) were reviewed. An examination of statistics for this industry from one industrial state indicates that the two main causes of disabling injury are machines and working surfaces. The three main types of disabling injury are strain or overexertion, being struck by or striking against an object, and falls or slips.

occupational health and environmental control

The health hazards associated with the manufacture of lead-acid storage batteries do not vary appreciably from company to company, except in severity and scope. On the other hand, health hazards may vary considerably in alkaline battery manufacture, depending on electrode metal types, compounding and mixing requirements, electrolyte used, type of seal required, and number of cells per battery. In each battery manufacture type, employees may be exposed to a variety of gases, dusts, vapors, mists, and fumes, and to high noise levels.

In the manufacture of lead-acid storage batteries, the significant health hazard is lead. Employee exposure to lead oxide fume and lead dust can occur during the handling of raw lead oxide powder, pasting, lead recovery, plate cutting or deburring, assembly and stacking of grids, and casting operations. Inhalation and ingestion are the primary means by which lead dust and oxide enter the body.

In the manufacture of alkaline batteries, employees may be exposed to airborne nickel, cadmium, zinc, and silver dusts and to mercury vapor. This occurs primarily during mixing of the compounds to form the paste. Skin exposure to these metals can also occur. Exposure to the oxide fumes of these metals (except mercury) can occur during spot welding of connector tabs to electrodes. Skin contact with the cell electrolyte—usually potassium hydroxide and lithium hydroxide—may occur during battery assembly.

In some cases, health hazards are not recognized because some materials used in manufacturing are identified only by trade names. Also, some materials contain mixtures of substances, making identification still more difficult. If the composition of a material cannot be determined, the information should be requested from the manufacturer or supplier. In many instances, they can provide Material Safety Data Sheets for the products. These sheets contain information such as the hazardous concentration level and physical characteristics of the substance, requirements for personal protective equipment, emergency procedures, and reactivities with other substances.

In identifying occupational health hazards, job hazard analyses should be made, showing the substances used, the number of employees at risk, products formed, and any by-products generated. The form of the products and by-products should be noted, i.e., a liquid, dust, vapor, mist, gas, or fume. The most likely routes of entry should also be noted, i.e., by mouth, skin, or inhalation. Methods of controlling exposure should then be noted.

A job hazard analysis may be made of each operation, or may be done by department. The survey should evaluate present conditions. Related activities, such as maintenance and service operations, should also be examined for health hazard potential. Some examples of unsuspected hazards are:

- Welding performed around chlorinated materials, causing the formation of toxic gases in addition to welding fumes.
- Use of forklift trucks with internal combustion engines, generating carbon monoxide and other hazardous exhaust gases.
- Mixing of certain cleaning agents, sometimes forming chlorine and other poisonous gases.

After completing the job survey, evaluate all exposure substances listed for the hazard potential. You should also determine if present controls are adequate. Safety data sheets and toxicology references can be used for the initial evaluation. Measuring air contaminant levels and evaluating controls (particularly ventilation) may require outside consultation in some cases. After the evaluation is completed, any required controls should be provided.

The following job health hazard analyses represent a survey of a battery reclamation operation in a lead-acid storage battery plant and a partial workplace survey of an alkaline storage battery manufacturer.

JOB HEALTH HAZARD ANALYSIS

Operation: Battery reclamation

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Number of employees	Job title	Exposure substance	Form[1]	Route of entry[2]	Control[3]
2	Forklift operator	Combustion products of propane	G	I	GV
		Lead	D	I	GV R (dust)
		Noise (92 dBA)			none
4	Reclaim workers	Lead	D	I	GV R (dust)
		Sulfuric acid	L	S	G (rubber) F
			M	I	R (acid-gas)
		Noise			none
		Rubber (from sawings of batteries)	D	I	R (dust)

1) Form: D = dust, L = liquid, V = vapor, G = gas, F = fume, M = mist
2) Route of entry: S = skin, I = inhalation
3) Control: LV = local ventilation, GV = general ventilation, R = respirator (type), G = gloves (type), F = face protection, O = other protection (type)

WORKPLACE HEALTH HAZARD ANALYSIS

Department	Job Description	Exposure Substance(s) (chemical or trade name)	Form(s)	Control	Remarks
4	Compounding	Nickel, cadmium, zinc	D	R(Dust), GV	settles on skin
			L	G(Rubber), O (Apron)	
	Treating	Nitric acid, cadmium nitrate, nickel nitrate	L, M	G(Rubber), O(Apron), LV	
7	Electrode fabrication	Nickel, cadmium	D	LV	grinding, spot welding, and cutting
	Spot welding	Nickel, cadmium	F	LV	
		Noise		None	not 8 hour a day exposure
	Cleaning battery containers	Perchloroethylene	L V	G(Impervious) LV	gloves approved for solvents

FORMS: D = dust; F = fume; G = gas; L = liquid; M = mist; V = vapor

CONTROLS: G = gloves (type); F = face protection; O = other (type); LV = local ventilation; GV = general ventilation; R = respirator (type)

Department	Job Description	Exposure substance(s) (chemical or trade name)	Form(s)	Control	Remarks
10	Encapsulating	Noise		None	not 8 hour a day exposure
	Rolling electrode and inserting into container	Lithium hydroxide	L	G(Rubber)	a few drops used
		Potassium hydroxide	L	G(Rubber)	a few drops used
12	Final assembly	Nickel, cadmium	F	GV	spot welding
		Polyvinyl chloride	G,V	GV	from plastic wrap during battery labeling

FORMS: D = dust; F = fume; G = gas; L = liquid; M = mist; V = vapor

CONTROLS: G = gloves (type) F = face protection O = other (type) LV = local ventilation GV = general ventilation R = respirator (type)

Air Contaminants

Various control methods can be used to prevent or reduce employee exposure to air contaminants. Some of these methods, which can be used singly or in combination, are:

Substitution of less toxic materials—use of 1,1,1-Trichloroethane for carbon tetrachloride.

Change of a process—e.g., an operation performed manually, now automated.

Isolation—placing the hazardous process in a separate room or in a corner of the building to reduce the number of persons exposed.

Ventilation—either local exhaust ventilation where contaminants are removed at the point of generation, or, if the air contaminant has a low order of toxicity, general dilution ventilation. (See "Occupational Health and Environmental Control".)

Administrative control—as a temporary measure, limiting the total amount of time an individual is exposed to a health hazard and rotating two or more workers each shift.

Training and education of employees—telling employees what hazards they are exposed to and how to reduce or limit exposure. (See "Employee Training".)

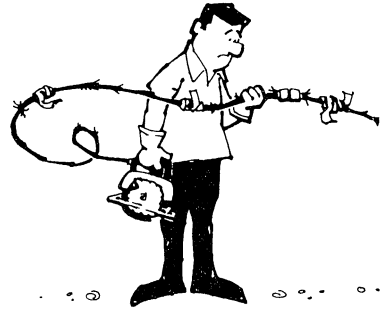
Personal hygiene—this cannot be overemphasized. Employees should wash their hands before eating and they should not be permitted to eat around toxic chemicals or in contaminated areas. If chemicals such as caustics, epoxies, and resins get on the skin, they should be washed off immediately. Clothing should be changed and washed daily if it becomes contaminated with toxic chemicals, dusts, fumes, or liquids.

Personal protective equipment—use of such items as respirators, hearing protection devices, protective clothing, and protective equipment. (See "Personal Protective Equipment".)

Power Tools

Employees who operate power tools should be instructed to:

- know the application, limitation, and potential hazards of the tool used
- select the proper tool for the job
- remove adjusting keys and wrenches before turning on tools



- not use tools with frayed cords or loose or broken switches
- keep guards in place and in working order
- have ground prongs in place or use tools marked "double-insulated"
- keep working areas free of clutter
- keep alert to potential hazards in the working environment such as damp locations or the presence of highly combustible materials and flammable vapors
- dress properly to prevent loose clothing from getting caught in moving parts
- use safety glasses, dust or face masks, or other protective clothing and equipment when necessary
- not surprise or distract anyone using a power tool

FREQUENTLY VIOLATED REGULATIONS

This section outlines the OSHA regulations which are most applicable to general plant conditions and operations found in the storage battery industry. The standards are listed in the same order as the OSHA regulations and the applicable points of each standard are summarized.

General conditions and controls are discussed. Your particular operation may vary, so some of these standards may not apply or additional standards may also be applicable. The control methods presented are only a brief, general suggestion as to how hazards may be corrected. For detailed information on control problems such as noise, air contaminants, and machine guarding, where specific designs must be implemented, you may need the services of a professional consultant.

walking and working surfaces

General Requirements

- All work areas, passageways, storerooms, and service rooms must be kept clean, orderly, sanitary, and as dry as possible. All spills should be cleaned up promptly. Floors in work areas must be kept free of scrap, chips, oil and coolant spills, and other debris.
- Areas which are constantly wet should have non-slip surfaces or mats where employees must walk or work.
- Every floor, working place, and passageway must be maintained free from protruding nails, splinters, holes, and loose boards.
- Where mechanical handling equipment (such as lift trucks) is used, sufficient safe clearance must be provided for foot and vehicular traffic.
- No obstructions that could create a hazard are permitted in the aisles.
- All permanent aisles must be marked and easily recognizable.
- Floorload capacities must be posted in a readily visible location (except for slab floors with no basement). The floorload capacity is the maximum weight which can be safely supported by a floor, expressed in pounds per square foot. If this information is not available, and when floorload capacity is in doubt, a competent engineer should be consulted.

The Standard Guardrail and Toeboard

As a general condition, a standard guardrail and toeboard are required wherever people walk beneath the open sides of a platform or under similiar structures or where things could fall from the structure (for example, into machinery below).

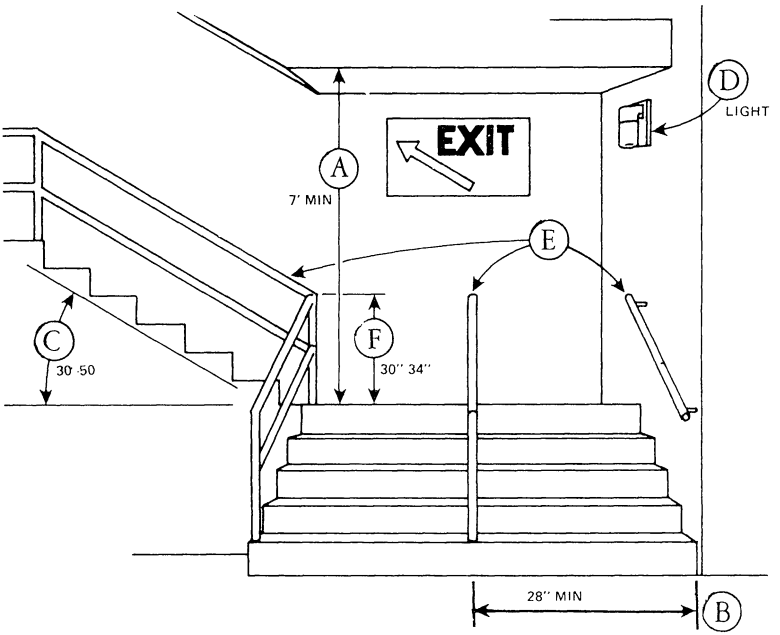
A standard guardrail consists of a top rail, intermediate rail, and posts. The nominal distance from the upper surface of the top rail to the floor, platform, runway, or ramp must be 42 inches. There must be an intermediate rail spaced approximately halfway between the top rail and the floor.

The guardrail can be of any configuration and construction that meets the basic dimension requirements (42 inches high with midrail), and can withstand 200 pounds applied in any direction at any point on the top rail.

- For wood railings, the rails and posts must be of at least 2 x 4-inch stock with posts spaced not more than 6 feet apart.
- For pipe railings, rails and posts must be at least 1 1/2-inch outside diameter pipe with posts spaced not more than 8 feet apart.
- For structural steel railings, the posts and rails must be of 2 x 2 x 3/8-inch angles or other metal shapes of equivalent strength with posts spaced not more than 8 feet apart.

The standard toeboard must be approximately 4 inches in height from the floor to the top edge, with no more than a 1/4-inch gap between the toeboard and the floor. The toeboard may be constructed of any solid or perforated substantial material, as long as the openings are smaller than 1 inch.

Fixed Industrial Stairs



- Riser height and tread width must be uniform throughout any flight of stairs.
- All treads must be reasonably slip resistant.
- Vertical clearance above any stair tread to any overhead obstruction must be at least 7 feet, measured from the leading edge of the tread. (A)
- The minimum permissible width of a stairway is 22 inches. If the stairway is a means of exit access, it must be at least 28 inches wide. (B)
- The angle to the horizontal made by the stairs must be between 30° and 50°. (C)
- All stairs should be adequately lighted. (D)
- If the tread is less than 9 inches wide, the risers should be open.
- The following requirements apply to flights of stairs having four or more risers: (E)

  a stair railing is required on each open side;

  if the stairway is less than 44 inches wide and both sides are enclosed, at least one handrail is required, preferably on the right side descending;

if the stairway is greater than 44 inches wide, a handrail is required on each enclosed side;

if the stairway is greater than 88 inches wide, an intermediate stair railing located midway is required.

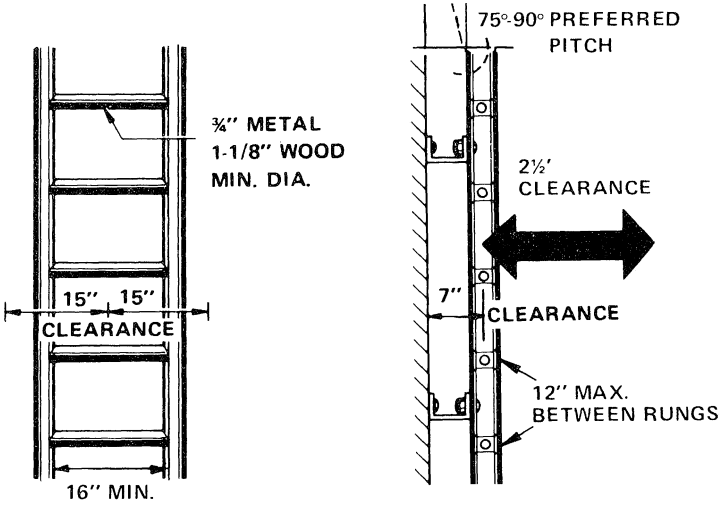
- The vertical height of a stair railing must be 30 to 34 inches, and it must be of construction similar to the standard guardrail. (F)

Portable Ladders

- Portable ladders must be maintained in good condition at all times with tight joints, securely attached hardware and fittings, and freely operating movable parts. They should be kept coated with a suitable protective material.
- All portable ladders must be inspected frequently. Defective ladders must be tagged "Dangerous - Do Not Use" and removed from service for repair or destruction. Ladders with broken or missing steps, rungs, or cleats, cracked or broken side rails, or other faulty equipment must not be used.
- Ladders should be stored where they will not be exposed to the elements; wood ladders should be stored where there is good ventilation.
- Metal ladders must not be used near energized electrical equipment.
- All ladders must be placed so that they have a secure footing. They may not be placed on boxes, barrels, boards, bricks, or other unstable bases to obtain additional height. Nonslip bases should be used.

Fixed Ladders

- Fixed ladders must be designed to withstand a single concentrated load of at least 200 pounds.
- Rungs of metal ladders must have a minimum diameter of 3/4 inch. Rungs of wood ladders must have a minimum diameter of 1 1/8 inches.

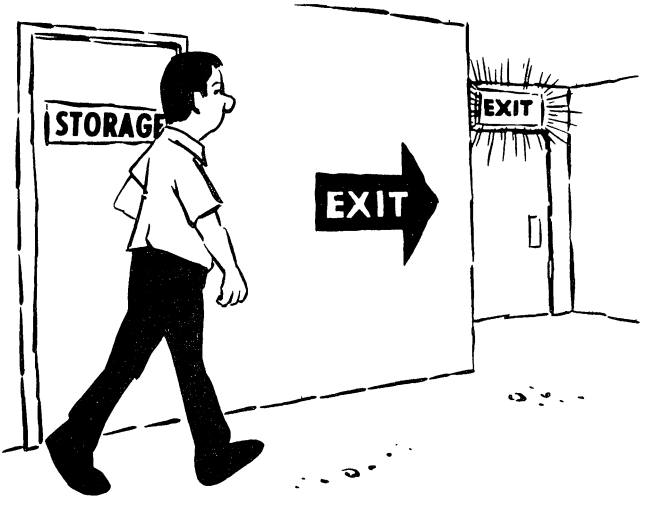


- Rungs must be at least 16 inches wide, be spaced 12 inches apart, and be free of splinters and burrs.
- Ladders, when their location so demands, must be painted or treated with a preservative to resist deterioration.
- The preferred pitch for safe descent is 75° to 90° unless caged. Ladders with 90° pitch must have a 2 1/2-foot clearance on the climbing side. There must be a 3-foot clearance on ladders with a 75° pitch.
- There must be at least a 7-inch clearance in back of the ladder to provide adequate toe space.
- Ladders must have cages if they are longer than 20 feet.
- Landing platforms must be provided on ladders greater than 20 feet long. A platform is required every 30 feet for caged ladders and every 20 feet for unprotected ladders.
- Side rails must extend at least 3 1/2 feet above landings.
- There must be a clear width of 15 inches on each side of the center line of the ladder, unless the ladder is equipped with a cage or well.

exits and exit markings

Size and Placement of Signs

- Every exit must have the word "EXIT" in plain, legible letters not less than 6 inches high with the strokes of the letters not less than 3/4 inch wide.
- The visibility of the sign must not be impaired by decoration, furnishings, or other signs.
- Doors, passageways, or stairways which are neither exits nor ways to an exit, but may be mistaken for an exit, must be clearly marked "NOT AN EXIT" or with a sign indicating their actual use, e.g., "STORAGE ROOM" or "TO BASEMENT".

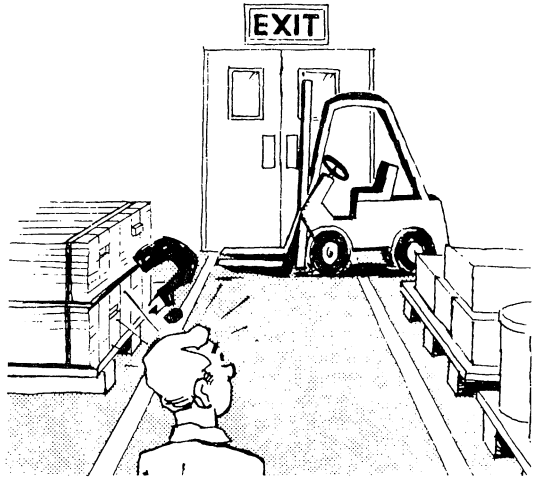


- In areas where the direction to the nearest exit may not be apparent to an occupant, an exit sign with a directional arrow must be used.

- Exit signs must be illuminated by a reliable light source if occupancy is permitted at night, or if normal lighting levels are reduced at times during working hours.

General Requirements for Exits

- The exit route must lead to a public way.
- Areas around exit doors and passageways leading to and from the exit must be kept free of obstructions.



- Exit access must be arranged so that it is unnecessary to travel toward any area of high hazard potential in order to reach the nearest exit (unless the path of travel is effectively shielded by suitable partitions or other barriers).
- A door from a room to an exit, or to a way of exit access, must be of the side-hinged, swinging type. It must swing out in the direction of travel if 50 or more persons occupy the room, or if it is an exit from an area of high hazard potential.
- No lock or fastening may be used which prevents escape from inside the building.
- Where occupants may be endangered by the blocking of any single exit due to fire or smoke, there must be at least two means of exit remote from each other.

occupational health and environmental control

Harmful dusts, gases, mists, and vapors may be generated during various battery manufacturing processes—electrode production, paste mixing, grid and small parts casting, charging or formulating, deburring, spot welding of connector tabs, and sanding of electrode contacts. In addition to exposure by inhalation, employees may come into skin contact with electrolytes, acid dip solutions, cleaning solvents, metal compounds (especially nickel, lead, and cadmium), and electroforming solutions.

A brief discussion covering the major health hazards found in each type of storage battery manufacturing with general recommendations for control is presented below.

LEAD-ACID STORAGE BATTERIES

Lead

Lead is the major air contaminant found in the manufacture of lead-acid storage batteries. Paste mixing, metal recovery from furnaces, grid and small parts casting, lug melting, oxide manufacture, and tab soldering can produce lead fumes or dust. Other metals such as antimony, arsenic, tin, and bismuth (which are added to lead to improve physical and chemical properties) generate fumes or dust which may be hazardous. Lead poisoning may occur through the inhalation of lead fume and dust or accidental ingestion of lead dust.

The classic symptom of lead poisoning is "wrist drop", a paralysis of the muscles which flex the wrist and fingers. But no one symptom indicates the occurrence of lead poisoning. At first, one may experience a general ill-feeling, fatigue, headache, nervousness, muscle and joint pains, and a disturbance of sleep. In the advanced stages of chronic lead poisoning, several body functions and organs such as the liver, kidney, and nervous system may be affected.

Local exhaust ventilation should be provided for all processes

generating lead fumes or dust. Good housekeeping practices and personal hygiene can reduce lead intake by inhalation and ingestion. Separate lockers for work and street clothes should be set up. If the operation is part-time, or if the circumstances dictate, the use of respirators is recommended.

(In the manufacture of alkaline batteries, connection wires leading to the terminals at the top of the battery are soldered with an electric iron and conventional tin solder. With adequate general ventilation, this operation should not result in any health hazard.)

Sulfuric Acid

Sulfuric acid, used in concentrations ranging from 14 to 39% for lead-acid battery electrolyte, may cause serious burns to skin and eyes. If skin contact does occur, serious burns can be avoided by rinsing the burned area immediately with running water. If acid should splash into the eyes, they should be rinsed immediately with running water for at least 15 minutes. Suitable facilities for immediate drenching or flushing of the eyes and body MUST be provided within the work area. Personal protective equipment should always be worn when working with sulfuric acid electrolyte. This includes face shield, safety glasses, boots, apron, and gloves. Contact lenses should never be worn by workers handling acid.

Always dilute concentrated or strong acid by slowly adding the ACID to WATER while mixing. Never add WATER to the ACID, as the reaction is violent and can splash acid over a large area. (When concentrated acid is added to water, it is normal for a large amount of heat to be generated and for the solution to become very hot.)

In battery charging areas, acid mist and explosive hydrogen gas are generated during the charging process. Adequate mechanical ventilation, preferably local exhaust, must be provided to prevent accumulation of the mist and hydrogen gas.

Stibine and Arsine

Overcharging batteries may produce stibine and arsine, when using batteries with plates of lead alloyed with antimony and arsenic. Stibine

and arsine are acute toxicants which affect kidney and liver functions. Both are also lung irritants. Arsine poisoning results in the passage of dark red urine, usually four to six hours after exposure, followed by low back pain and an inability to urinate. Stibine poisoning results in headaches, nausea, and weakness, followed by passage of dark red urine a few hours after exposure. Adequate ventilation must be provided in battery charging areas to prevent accumulation of these contaminants.

An emergency eye wash fountain must be located near areas where sulfuric acid is used.

Chelation Therapy

In some cases of lead exposure, drugs are used to lower the level of lead in workers' blood. They are often used in place of environmental controls of lead exposure. The drugs used are called chelating agents, the most common being calcium disodium EDTA. The drugs can be useful for reducing blood lead level after exposure to high concentrations of lead over a short period of time. However, long term use of these drugs for the control of lead exposure can have serious health effects.

Beside removing the lead from the body, chelating drugs also remove other metals which the body needs. The drug may cause a chemical imbalance in the body, and may cause damage to the nerves, blood, and kidneys. If taken over a long period of time, the chelating agent may actually lower the body's ability to handle lead exposure.

Because research shows chelating agents may cause neurological and renal (kidney) damage, the use of these agents is not recommended, except in treating acute exposure.

ALKALINE STORAGE BATTERIES

Nickel

Excessive quantities of nickel dust may be released into workroom air during blending with nickel powder and the forming of nickel plaques before they are processed into electrodes. Nickel dust is also produced during the shearing and abrasive blasting of plates, and the grinding and buffing of electrode contacts. Inhalation of nickel dust can irritate the membranes of the upper respiratory tract. Skin exposure from handling nickel powder, nickel plates, and electrode treating solutions containing nickel may lead to "nickel itch", a dermatitis which chiefly affects the hands and arms. Properly designed local exhaust ventilation should be in use in all operations which involve nickel dust exposure. If ventilation is not feasible, a respirator approved for use with nickel should be worn. Direct contact with the nickel salt solution used in plate forming must be avoided to prevent "nickel itch". Suitable protective clothing should be worn to prevent skin exposure.

Cadmium

Cadmium dust can be produced during compounding of cadmium paste, grinding and buffing of connector tabs, and cutting and shearing of cadmium plates. Cadmium oxide fume is given off when connector tabs are spot welded to battery plates. Exposure to cadmium dust or fume can result in cough, headache, dryness of throat, and shortness of breath. If exposure is intense, severe shortness of breath, pulmonary edema, persistant cough, and pain in the chest can result. Kidney function may also be affected. Inhalation of cadmium fume can also cause metal fume fever, a condition similar to influenza. The symptoms usually occur a few hours after exposure and include a metallic taste in the mouth, dryness of nose and throat, weakness, fatigue, muscular and joint pains, fever, chills, and nausea. The symptoms usually last less than 24 hours. Local exhaust ventilation should be provided at any operation where cadmium dust or cadmium oxide fume is produced. As an added precaution, approved respirators should be worn.

Silver

Exposure to silver dust can occur during compounding of silver powder to form the electrode. Exposure can also occur during preparation of silver powder from the bullion. Absorption of silver into the body can result in permanent blue-gray discoloration of the skin, mucous membranes, and eyes. Local pigmentation can also occur at the point where fine particles of silver enter through breaks in the skin. All operations in which silver dust may be produced should be ventilated. Suitable protective clothing should be worn to prevent skin contact with silver.

Mercury

Exposure to mercury vapors and mercuric compound dust can occur during handling and weighing of the mercury compounds. Mercury exposure can also result from the treatment of waste water, as elemental mercury forms in the sludge. Special handling techniques must be used to prevent excessive exposure through skin contact and inhalation. Grinding the edges of the negative battery plates can discharge some mercuric oxide dust. Excessive exposure to mercury vapor or mercuric oxide dust

can produce either acute (short-term exposure) or chronic (long-term exposure) mercury poisoning. Symptoms of acute mercury poisoning include tightness in the chest, coughing, difficulty in breathing, and chest pains. Acute poisoning can result from accidental exposure to the metal or its compounds. Acute skin reactions have also occurred following skin contact with mercury compounds. Mercury poisoning is more frequently chronic, resulting from mercury accumulating in the body over a period of time. Chronic mercury poisoning is characterized by emotional disturbances and tremor or shaking of the body, particularly of the hands. Some individuals may develop inflammation of the gums, roof of the mouth, and tongue. These conditions are often accompanied by loss of teeth. Other signs and symptoms may include increase of saliva, loss of appetite and weight, and disturbances of the digestive and kidney functions and organs. The kidneys, liver, brain, heart, and lungs may be affected.

Mercury poisoning can result from eating foods that have been contaminated with mercury or its compounds, smoking contaminated tobacco, or from careless handling of contaminated objects. Mercury can enter the body through contact with the skin, where it is absorbed through the hair follicles and sweat glands. Skin irritation (dermatitis) can also result. Mercury or its compounds in the eyes can also cause injury. All operations in which mercury vapor or compound dust is released in the work area should have local exhaust ventilation. Suitable protective clothing should be worn to prevent skin contact with mercury. Personal hygiene is also important in the control of mercury exposure. Eating, smoking, and drinking should be prohibited in areas where mercury is used.

Zinc

Exposure to zinc dust can occur during compounding of pastes for the electrode, grinding and buffing of electrodes, and during cutting and shearing of plaques. Exposure to zinc oxide fumes can occur during spot welding of connector tabs to electrodes. Inhalation of zinc oxide fumes can result in metal fume fever (see symptoms above). Operations which produce zinc oxide fume should be well-ventilated.

Carbon

Exposure to carbon dust can occur while mixing carbon with water

to form the electrode paste for lithium batteries. Inhaling carbon dust can irritate the mucous membranes of the nose and throat. The dust can also irritate the eyes. Appropriate eye protection, good work practices, personal hygiene, and good housekeeping will probably be necessary to reduce employee exposure to carbon dust. Exhaust ventilation may also be needed to control the dust released during the addition of carbon to the mixer.

Asbestos

Asbestos is sometimes a component of the separators used in batteries. When these separators are cut or handled, asbestos fibers may be released. Exposure to asbestos fibers can cause a form of lung fibrosis called asbestosis. It has also been associated with the production of cancers of the lung, pleura, and peritoneum. In its advanced stages, asbestosis may be evident by characteristic indications on X-ray films, by reductions in lung capacity, or by certain clinical signs such as finger clubbing or dry cracking sounds within the lungs. The most important symptom is shortness of breath. The disease is progressive even after exposure ceases. As a general rule, if asbestos is a component of the separators, substitute materials for separators should be considered.

Potassium Hydroxide/Sodium Hydroxide

Exposure to potassium hydroxide—the electrolyte used in many alkaline batteries—can occur during addition of the electrolyte to the battery cases. In the manufacture of silver-zinc batteries, potassium hydroxide mist may also escape from electroforming tanks during electrode production. Potassium hydroxide is a highly irritating substance. Skin contact can result in severe chemical burns and the development of a severe dermatitis. Inhaling potassium hydroxide can irritate the mucous membranes of the nose and throat and if excessive exposure occurs, severe irritation of the lung tissue can result.

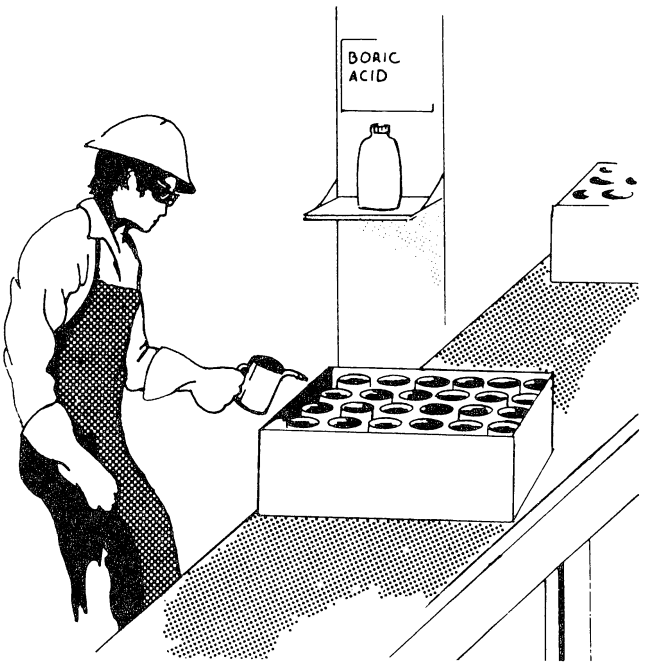
Employee exposure to sodium hydroxide mist and skin contact with this caustic can occur during electroforming of the electrodes in nickel-cadmium battery manufacturing. The health effects of sodium hydroxide are similar to potassium hydroxide.

Since the addition of potassium hydroxide or the handling and

storage of sodium and potassium hydroxide solutions may subject workers to splashes of these highly irritating and corrosive substances, workers must wear protective clothing and eye and face protection. Emergency eye wash facilities should be provided nearby. Local exhaust ventilation for the electroforming tanks should be provided to maintain concentrations of airborne alkaline mist below permissible levels.

Lithium Hydroxide

Exposure to lithium hydroxide—also an electrolyte used in many alkaline batteries—can occur during its addition to the battery cases. The primary effect of inhalation of lithium hydroxide is irritation of the upper respiratory tract.



Addition of electrolyte to alkaline battery cases. Note neutralizing solution of boric acid in case of **skin** contact. (Do **not** use boric acid in case of acid splash in eyes.)

Epoxy Resins

Alkaline battery cases are frequently sealed with epoxy resins. Skin contact with these resins can lead to dermatitis and sensitization dermatitis, an allergic reaction which comes about after repeated exposures which previously have shown no apparent effect. Efforts should be made to avoid skin contact with epoxy resins. Protective clothing, including gloves and apron, should be worn. Good personal hygiene is a must in preventing dermatitis. Epoxy resins on the skin should be washed off immediately with soap and water. Adequate ventilation should be provided to remove any vapors arising from the epoxy resins.

Potting Compounds

The electrodes in some alkaline batteries are set in the bottom of the case by an epoxy potting compound. This compound may contain silicate fillers, such as wollastonite. Mechanical ventilation should be provided to control the dust released when these compounds are weighed and dispensed. Protective clothing should be worn to prevent skin contact.

Polyurethane Foams

The cells in multiple-cell batteries are sometimes held in place by polyurethane foams, many of which contain toluene diisocyanate (TDI) or other isocyanates. Mixing, dispensing, and curing of the foam may cause the release of isocyanate vapors. Inhalation of the isocyanate vaporscan irritate all parts of the respiratory tract, and cause bronchial spasms and sensitization with asthma-like symptoms. Severe dermatitis can result from skin contact with the isocyanates and foam mixture. Employees should wear protective clothing to prevent skin contact with the foam. All foaming operations (mixing, dispensing, etc.) should be done in well-ventilated areas.

Nitric Acid (HNO_3)

Employee exposure to nitric acid mist can occur during electroforming of the electrodes. Inhalation of nitric acid mist may lead to chronic bronchitis and severe irritation of mucous membranes. Skin contact will

produce immediate and severe penetrating burns. Nitric acid can produce severe eye damage resulting in vision impairment, which can become permanent. Local exhaust ventilation should be in effect to control nitric acid mists. Protective clothing, gloves, goggles, and face shield **must** be worn to protect against accidental splashes of nitric acid. Suitable facilities for drenching and flushing the eyes and body must be provided within the work area.

Phosphoric Acid

The electropolishing of stainless steel battery cases in a phosphoric acid bath may release phosphoric acid mist into the workroom. Local ventilation should be provided at phosphoric acid dip tanks. Employees should wear protective clothing, and eye and face protection to avoid direct contact with the acid. Appropriate washing facilities must be available.

Hydrogen, Carbon Monoxide, and Methane

During the initial phase of electrode fabrication, nickel plaques are sintered in reducing atmosphere furnaces. The atmosphere supplied to the furnaces contains a mixture of flammable gases including hydrogen, carbon monoxide, and methane. It is generated from natural gas in a specific unit. Any combustible gases escaping from the furnaces are generally burned off at the furnace ends. However, a series of interlocks, controls, and inert gas purge safeguards must be provided to counteract flame failure and to prevent the entry of air into the furnaces and the subsequent formation of explosive atmospheres.

Miscellaneous Hazardous Substances — Alkaline or Lead-Acid Batteries

The use of talc for dusting molds has caused talcosis or talc pneumoconiosis. The major symptoms are a chronic productive cough and progressive shortness of breath.

Coal tar pitch has been used as a sealant for batteries and contains benzo(a)pyrene—a known carcinogen—as well as other compounds (e.g., pyrenes) which are known photosensitizers.

A few companies manufacture their own battery cases using injection molding machines. These use various plastics such as polypropylene, polycarbonates, polystyrene, etc. Depending on the plastic and the operating temperature during molding, various vapors (e.g., formaldehyde, amines, styrene, and acrylates) may be generated. They can irritate the eyes and lungs at low air concentrations, and may cause nausea, headache, and dizziness at high concentrations.

Various materials (e.g., fibrous glass, paper, and polyvinyl chloride) are used as separators or enclosures for the grid plates. Under normal conditions, these materials (except asbestos, which is currently not in use) do not present a problem. However, the manufacture of paper or resin banded separators may produce significant concentrations of a phenolformaldehyde fume. If polyvinyl chloride separators are used and are overheated, hydrochloric acid fumes will be released. Both phenolformaldehyde vapors and hydrochloric acid fumes are upper respiratory, skin, and eye irritants. Operations which may lead to exposure to any of the above materials should be well-ventilated.

The high current density from alkaline batteries can cause severe electrical burns from the heating of rings and other jewelry worn by packaging and shipping personnel. Jewelry should not be worn by employees who handle alkaline batteries.

Solvents

Employees may be exposed to vapors of various organic solvents (e.g., trichloroethylene, perchloroethylene, and 1,1,1-trichloroethane) used in several processes. Typical of these operations are dip cleaning of battery plates and cases, cleaning stencil screens and tools, and paint dipping and drying angle iron battery racks and trays. Adverse health effects of exposure to many organic solvent vapors include irritation of the eyes, nose, throat, and lungs; dizziness; headache; and sensations of drunkenness. All solvent cleaning should be done in well-ventilated areas. Vapor degreasing tanks using cooling coils to condense vapors should be checked periodically for proper operation.

Organic solvents can also dissolve the natural protective skin oils, causing primary irritation dermatitis and localized skin injury. This makes the skin vulnerable to other harmful substances. Some solvents can enter the body directly by skin absorption, which may cause systemic poisoning.

Employees who handle solvents should wear protective gloves which are impervious to the solvent, and should use other suitable protective clothing to reduce skin contact with the solvent. Good personal hygiene is also important in preventing skin problems associated with solvent contact.

Some degreasing agents (most notably trichlorethylene) can decompose under the influence of ultraviolet radiation from welding. This forms phosgene, a highly toxic gas. For this reason, all welding should be done well away from degreasing operations.

The use of organic solvents also presents a fire and explosion hazard due to the flammability and volatility of these materials. Cleaning operations should be conducted in well-ventilated areas. All electrical equipment used near cleaning operations should be properly grounded to reduce the potential of spark.

Carbon Monoxide (CO)

This colorless, odorless gas can be produced by industrial trucks using gasoline or liquefied petroleum. Other sources of carbon monoxide

are the gas-fired furnaces used to sinter and anneal nickel plaques. Symptoms of excessive carbon monoxide exposure include headache, fatigue, poor judgment, shortness of breath, weakness and dizziness. Properly maintained combustion equipment can help prevent the generation of carbon monoxide. Furnace combustion chambers should be vented outside. Also, the use of battery-powered industrial trucks to reduce CO exposure should be considered.

Heat Stress

The temperatures in plants manufacturing lead-acid storage batteries are normally below the maximum that the body can tolerate. The limit may be exceeded during hot weather, however, when doing hard work in such areas as casting or melting.

Early symptoms of heat stress are weakness, extreme fatigue, dizziness, nausea, headache, and thirst. More advanced symptoms are arm, leg, and stomach muscle spasms; irregular or increased heart beat; extreme thirst; and fainting. Further exposure to heat may result in unconsciousness.

If the employee notices any of these signs, he should move to a cool place, rest, and drink small amounts of cool water. If symptoms persist, prompt medical attention should be sought.

To prevent heat stress, proper clothing must be worn. Reflective clothing will reduce the amount of radiant heat reaching the body. Employees should drink plenty of fluids and increase their intake of salt. Lack of water reduces the cooling effect of perspiration; lack of salt interferes with the proper functioning of the body's systems. Get as much cool air into the work area as possible—open windows and keep the ventilation passage clear. One of the best ways to avoid heat stress is acclimatization. If the body is allowed to accustom itself to high heat gradually—that is, a short period the first day, a longer period the second day, and so on—within a week or so, a full shift of hard work in a hot area should produce few ill effects. Keeping in good physical condition will help the body to adjust.

The following is a summary of selected hazards and controls for manufacturers of storage batteries.

HAZARD	CONTROL
Lead, cadmium, zinc, silver, and nickel fumes or dust; mercury vapor	Local exhaust ventilation, personal protective equipment (including approved respirators), and good housekeeping and personal hygiene
Acids and acid mists, caustics, electrolytes, alkaline mists	Personal protective equipment: gloves, aprons, boots, goggles, face shields, etc., local exhaust ventilation, eye wash fountains and deluge showers
Epoxy resins, epoxies, polyurethane foams	Personal protective equipment, personal hygiene, and local exhaust ventilation
Heat stress	Protective clothing, acclimatization, drinking sufficient water, and rest periods in cool areas
Noise	Engineering controls, limiting exposure time, and hearing protection
Falls, slips, and trips	Good housekeeping, proper footwear, and non-skid flooring
Falling objects	Proper stacking, toeboards, proper materials handling, hard hats, and foot protection
Shearing, pinching, or rotating machine parts	Machine guarding

HAZARD	CONTROL
Fire	Proper storage, handling, and disposal of flammables and combustibles, good housekeeping, ventilation in storage areas, and grounding of electrical tools
Lifting	Using correct method when lifting by hand and use of hoists for heavy loads
Electrical shock	Use of only grounded or double-insulated tools and prohibiting wearing of bracelets or rings by packers and shippers
Solvents	Local exhaust ventilation, gloves, and good personal hygiene

Air Contaminants

When employees are exposed to hazardous concentrations of airborne contaminants, exposure must be reduced to acceptable levels by either engineering or administrative methods. **Respirators are acceptable controls only while engineering controls are put into effect, or if engineering controls are not technically feasible.**

The primary methods of controlling exposure are substitution of less hazardous substances or processes and mechanical exhaust ventilation. Isolation and automation can also be used to reduce exposure to hazardous substances.

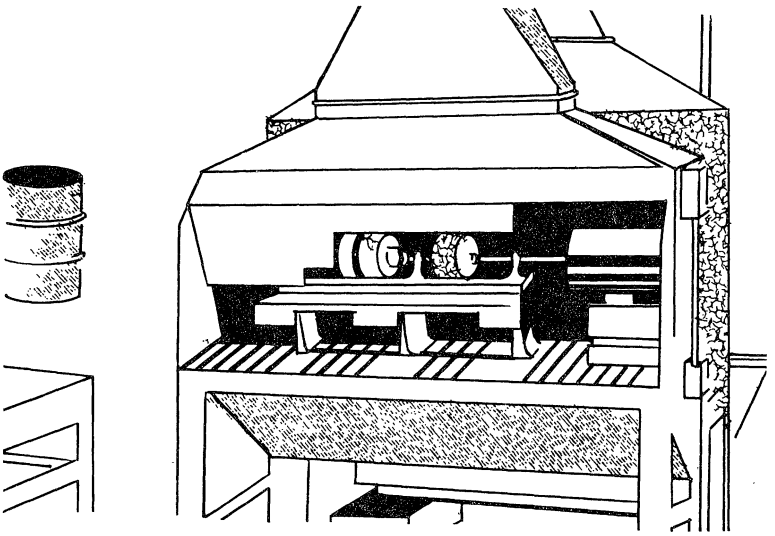
SUBSTITUTION Substitution, as it applies to the use of solvents, may have several advantages. For example, substitution of a petroleum naphtha for xylene may reduce the overall toxicity of the formulation. If the substitution of a substance raises the flash point of the formulation to above 100°F, the formulation may be taken out of the flammable liquid class, reducing the fire hazard and easing storage requirements.

While the substitution principle has limited uses, it should be used wherever possible to reduce the hazard potential.

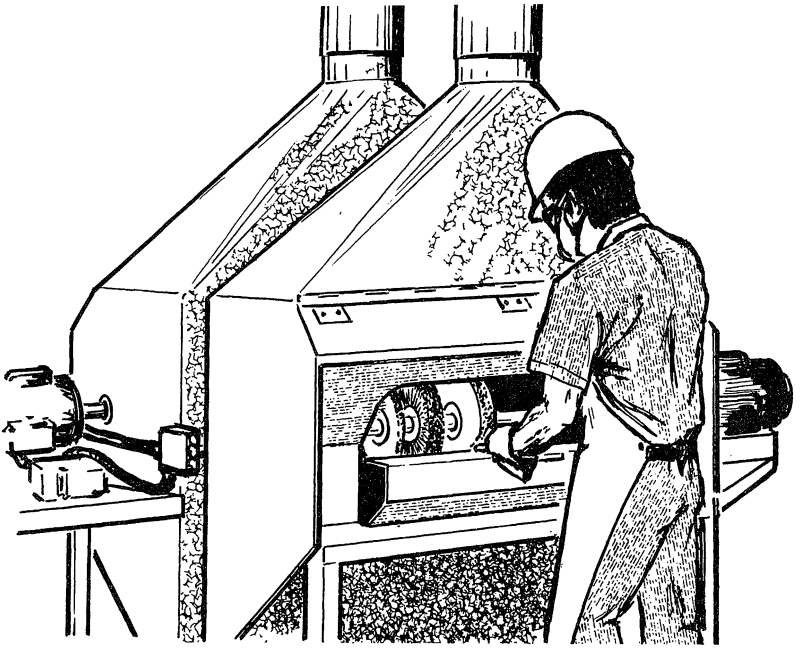
MECHANICAL VENTILATION Mechanical exhaust ventilation is the first choice for control of hazardous air contaminants in most cases. A properly designed local exhaust or dilution ventilation system can either remove air contaminants which may be present, or lower the concentration of fumes, vapors, dusts, mists, or other contaminants generated in the working environment. This can reduce or eliminate health or fire hazards.

Local Exhaust Ventilation In general, local exhaust systems should be installed wherever a large amount of air contaminant is generated, or where a small amount of an extremely hazardous substance may become airborne. Local exhaust ventilation removes the hazardous substance at or near its point of origin, and prevents it from being drawn through the breathing zone of the worker. Local exhaust ventilation is recommended, as it usually performs more efficiently than general dilution ventilation and prevents air contaminants from being circulated throughout the work area.

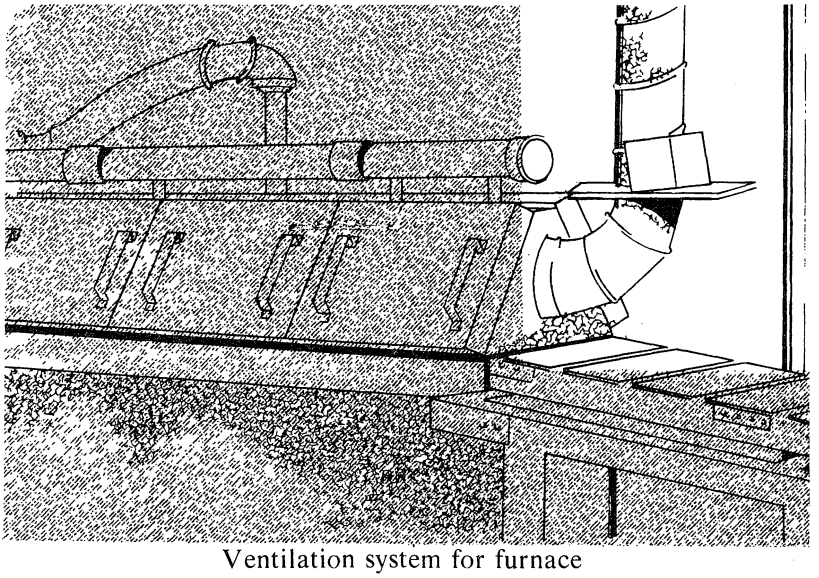
The following pictures illustrate local ventilation systems found in storage battery manufacture:



Local exhaust system providing "downdraft" ventilation



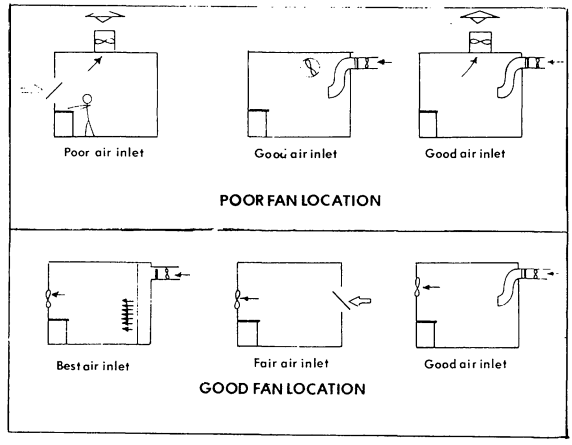
Ventilation system for deburring and grinding operation



Ventilation system for furnace

General Dilution Ventilation General dilution ventilation systems pull air through the work area to dilute air contaminants to a lower, non-hazardous level. They require a greater volume of air flow for efficient operation than do local exhaust systems. General dilution ventilation may be an effective control for areas where low concentrations of hazard-

ous substances are generated. It may also be used effectively in some flammable liquid storage areas or with substances with low hazard potential. The effectiveness of dilution ventilation as a control mechanism depends on air inlet and fan location and their spatial relationship to one another. The figures below illustrate air inlet configuration with good and poor fan locations.



PRINCIPLES OF DILUTION VENTILATION

A ventilation hood should be designed to capture the contaminant at the source. There is no "universal" hood. Many hoods in use are the common "Laboratory Style Hood". Slotted-side draft hoods along the back of the bench or slotted-top downdraft ventilation may work well for open bench tops. Small canopy hoods may cover a piece of equipment to capture the contaminant released by the equipment.

A pressure sensing gauge should be installed where the hood enters the duct work to measure the hood static pressure. The pressure can be monitored daily to assure proper operation of the system. The gauge can be marked to indicate the limit of acceptable operating conditions. Any filter inserted in the exhaust system must be cleaned or changed on a regular basis, particularly if the hood static pressure drops below acceptable levels.

"The Industrial Ventilation Manual, 14th Edition,"—published by the American Conference of Governmental Industrial Hygienists—provides excellent data for hood design as well as other aspects of ventilation for various operations (e.g., welding, hoppers, and filtering).

The design of a ventilation system is complex. The volume of air

which needs to be moved, the velocity required to capture and carry the contaminants, the type of fan which will exhaust the needed air volume, the placement of the exhausts and makeup air inlets, and the overall positioning of the system must all be determined.

A design engineer and an industrial hygiene engineer should be consulted when installing a total environmental control system. Contaminants removed from the breathing zone should be collected by an appropriate air pollution control system before discharge to the atmosphere.

Problems can occur with ventilation systems. Maintenance department personnel, as well as operating personnel, should be aware of these problems:

Design and Installation

- An error may have been made in the design.
- The system may not have been installed according to original design.
- Additional hoods or other exhaust equipment may have been added to the system, reducing the air flow through other hoods.

Hood System

- Adjustable slots may have been altered.
- The hood may have been modified, changing the size of the hood openings.

Duct System

- The duct may have become partially plugged.
- If dampers are used to "balance" the system, the damper settings may have been changed.
- Some ducts contain fused dampers that close in case of a fire. These fuses may melt, causing the damper to close.
- A duct joint may have worked loose or become separated.
- If acids or corrosive or abrasive materials pass through the ducts, the ducts may develop rust holes.

Motors and Fans

- Belts may have become loose or broken.
- Pulley sizes may have been changed.
- Voltage may be low, and fan may be undersized.
- The fan may have been installed backwards.

- The motor may be wired wrong and is rotating backwards. (A centrifugal fan, when running backwards, will **not** reverse the air flow but will pull a lower volume of air.)
- The fan blades may have become coated with fume or dust particles.
- The wrong type fan may have been selected.

Air Cleaning Devices

- The filters may have become clogged.

Whenever air is exhausted from a room, it has to be replaced by make-up air. If it is not provided, the ventilation system may not operate properly. The area or room should, however, be under a slight negative pressure.

Abrasive Blasting

If your operation includes abrasive blasting (e.g., of battery plates), the following requirements apply:

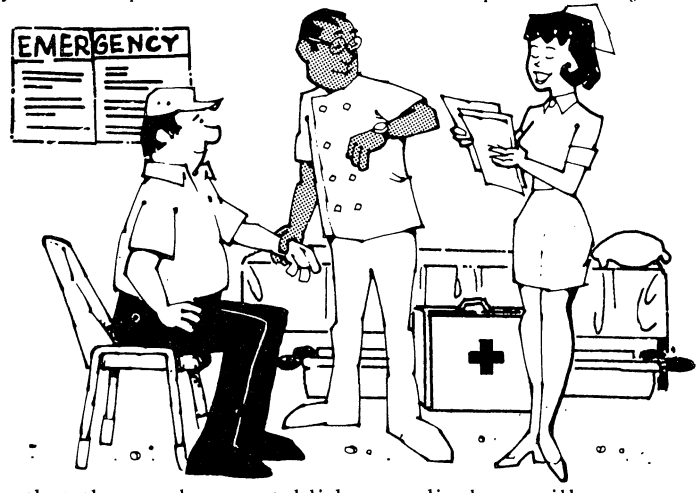
- Blast-cleaning enclosures must have exhaust ventilation. During blasting, a continuous inward flow of air should be maintained at all openings in the enclosure to prevent spurts of dust from escaping into adjacent work areas.
- Where hard, deep-cutting abrasives are used, observation windows must be made of safety glass protected by screening.
- NIOSH-approved respirators for abrasive blasting must be worn by all operators when working inside blast-cleaning rooms.
- The air for supplied-air abrasive blasting respirators must be free of harmful quantities of dusts, mists, and noxious gases. The air from the regular compressed air line of the plant may be used for the abrasive blasting respirator if the following conditions are met:
  - — a trap and carbon filter must be installed and regularly maintained to remove oil, water, scale, and odor;
  - — a pressure reducing diaphragm or valve must be installed to reduce the pressure down to requirements of the particular type of abrasive blasting respirator;

— an automatic control must be provided to either sound an alarm or shut down the compressor in case of overheating.

- Operators must wear heavy canvas or leather gloves and aprons or equivalent as protection from the impact of abrasives.
- Safety shoes must be worn where heavy pieces of work are handled to protect against foot injury.

Medical Surveillance

The manufacture of storage batteries results in employee exposure to such health hazards as lead, cadmium, nickel, antimony, and mercury. If employees are exposed to these substances as a part of their job, it is important that the employer establish a medical surveillance program to chart employees' exposure and to identify excessive exposure. A medical surveillance program might include:

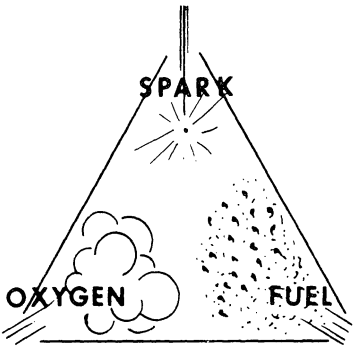


- A physical examination before employment, which would include a blood and urine examination.
- A periodic medical examination—at least once a year—which would include the above tests.

The medical surveillance program should be under the direction of a physician familiar with the medical aspects of exposure to toxic substances.

Fire Protection

Your plant has everything a fire needs:



FUEL

Fuel, gas, hydrogen generated during charging operations; packing and cleaning materials; paint and solvents; sealing compounds, plastics, trash.

OXYGEN

Oxygen for burning; liquid oxygen; air.

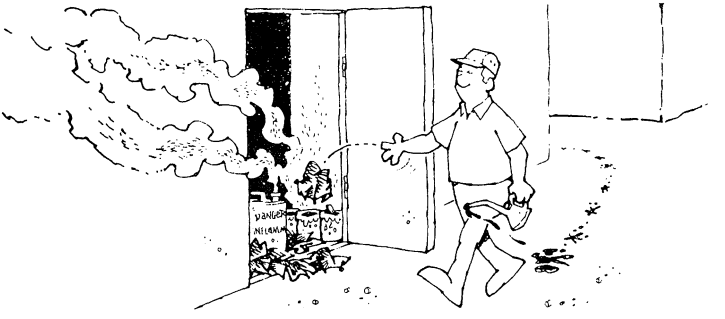
IGNITION SOURCE

Flame; spark; heat; hot metal; spontaneous sources; electrical.

If these essentials combine, a fire will start.

Some common causes of fires in businesses are electrical malfunctions, open flames, sparks, hot surfaces, and smoking. Proper maintenance and periodic inspections of the facility can reduce the likelihood of fires from these sources.

Combustible sweeping and cleaning compounds (e.g., oil-treated sawdust), floor coatings containing low flash-point solvents, oily mops and rags, and rubbish are also fire hazards. Sweeping compounds and



rubbish should be disposed of regularly. All oily mops and rags must be stored in closed metal containers.

Occupational Noise Exposure

Excessive noise can cause permanent hearing damage, yet the noise standard is one of the most commonly violated standards. It is management's responsibility to make sure employees are not exposed to noise levels in excess of the standard.

The current standard is 90 decibels, A-weighted (dBA), for an 8-hour exposure. Even at this noise level, hearing damage can be expected in some individuals. As the noise level is increased, the permissible exposure time decreases (e.g., if the level is 100 dBA, the permissible exposure time is 2 hours). The table on the following page estimates noise levels and the maximum exposure times allowed.

A noise survey by trained personnel should be made. If an employee's noise exposure is in excess of the standard, a hearing conservation program is required. Such a program would include periodic noise measurement, engineering and administrative controls, hearing protection, and audiometric testing.

The goal of the hearing conservation program should be to develop engineering controls to reduce noise exposure. Engineering controls could include enclosing the noisy equipment, acoustical treatment of walls to reduce noise reflection, vibration damping of noisy machines, and replacing metal-to-metal contact with synthetic material-to-metal contact.

Administrative controls—designed to limit the exposure time to excessive noise—can also be used. However, complications may arise when a worker must be shifted to a job which has a different pay scale or classification.

If engineering or administrative controls are not feasible, hearing protection is required. There are many forms of ear protection, such as ear muffs or ear plugs. Some are more effective than others, depending on the noise level, the frequency of the noise, and how well they fit the individual. It is necessary to provide protection that is effective and yet reasonably comfortable to the wearer.

It may soon be a requirement—and it is considered good practice—to have hearing checked by audiometric testing every year for all employees exposed to 85-90 dBA noise levels for 8 hours daily.

PERMISSIBLE NOISE EXPOSURES

NOISE SOURCES	SOUND LEVEL dBA	MAXIMUM EXPOSURE PER DAY dBA	INDICATORS OF LEVEL (SPEAKING EFFORT REQUIRED BETWEEN TWO PERSONS AT VARIOUS DISTANCES)
PNEUMATIC CHIPPER (AT 5 FT.) CHAIN SAW (AT EAR) ROCK N ROLL BAND RIVETING MACHINE	115	15 MIN.	NEARLY IMPOSSIBLE TO COMMUNICATE BY VOICE
CASTING SHAKEOUT AREA	110	30 MIN.	VERY DIFFICULT TO COMMUNICATE BY VOICE
PUNCH PRESS	105	1 HR.	SHOUT WITH HANDS CUPPED BETWEEN MOUTH AND OTHER PERSON'S EAR
PNEUMATIC AIR HOIST 4000 LB.	100	2 HR.	SHOUT AT 0.5 FOOT
POWER LAWN MOWER (AT EAR) INJECTION CASTING MACHINE	95	4 HR.	SHOUT AT 1 FOOT
AUTOMATIC SCREW MACHINE NUT BLANKING		6 HR.	
VANEAXIAL VENTILATING FAN (1500 CFRM) BOILER ROOM	90	8 HR.	NORMAL VOICE AT 0.5 FOOT RAISED VOICE AT 1 FOOT SHOUT AT 2 FEET TELEPHONE USE IMPOSSIBLE
DIESEL TRUCK (40 MPH AT 50 FT.) ARC WELDER MILLING MACHINE (AT 4 FT.) PNEUMATIC DRILL			NORMAL VOICE AT 1 FOOT RAISED VOICE AT 2 FEET SHOUT AT 4 FEET
GARBAGE DISPOSAL (AT 3 FT.)	80		NORMAL VOICE AT 1.5 FEET RAISED VOICE AT 3 FEET SHOUT AT 6 FEET
INSIDE A CAR (50 MPH)	75		NORMAL VOICE AT 2 FEET RAISED VOICE AT 4 FEET SHOUT AT 8 FEET

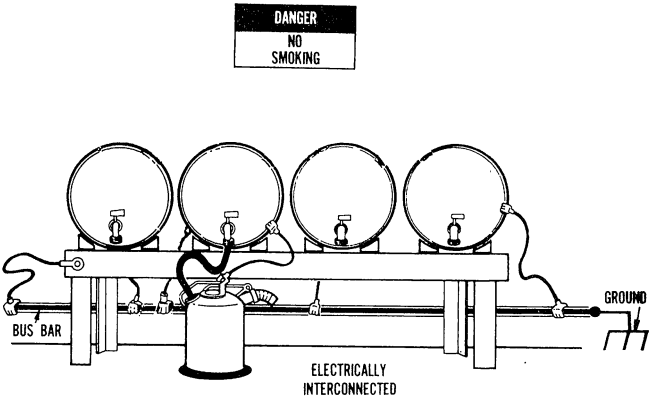
hazardous materials

Flammable and Combustible Liquids

Flammable and combustible liquids are identified by how easily they ignite (the flash point). Flammable liquids ignite more readily than combustible ones. Examples of flammables are gasoline, acetone, and lacquer thinner; examples of combustibles are kerosene, fuel oil, and Stoddard solvent.

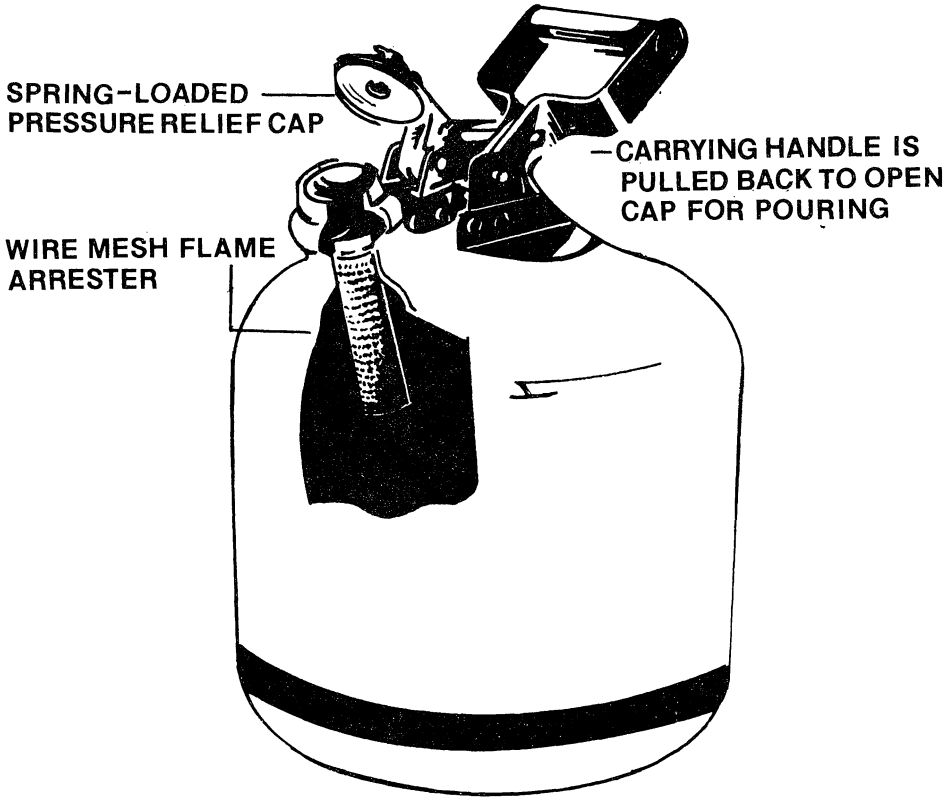
Connections on all drums and piped systems of flammable and combustible liquids must be vapor and liquid tight.

When flammable liquids are transferred from one container to another (e.g., from a bulk container to a portable container), the containers must be bonded and grounded. This practice prevents electrical discharge (i.e., sparks) from the accumulation of static charge because of the transfer process.



All spills of flammable and combustible liquids must be cleaned up promptly. Cleanup personnel must use appropriate personal protective equipment. If a major spill occurs, remove all ignition sources and ventilate the area. These liquids must never be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.

Supplies of flammable and combustible liquids must be stored in approved, fire-resistant safety containers equipped with self-closing lids. These containers can be purchased from an industrial supply house.



An approved safety container

All flammable liquids must be kept in closed containers when not in use.

Combustible waste material, such as oily shop rags and paint rags, must be stored in covered metal containers and be disposed of daily.

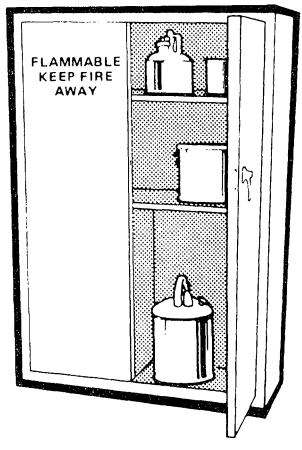
All storage areas must be posted as "NO SMOKING" areas.

Storage Cabinets

Storage cabinets must be distinctly labeled "FLAMMABLE — KEEP FIRE AWAY".

Metal cabinets must be constructed of at least no. 18 gauge sheet iron, double-walled with a 1 1/2-inch air space and tight joints. Doors must have three-point locks and the sill must be at least 2 inches above the bottom of the cabinet.

Wooden cabinets must be constructed of at least 1-inch plywood. All joints must be rabbetted and fastened in two directions with flathead wood screws.



Inside Storage Areas

Each inside storage area must be prominently posted as a "NO SMOKING" area. Openings to other rooms or buildings must be provided with noncombustible, liquid-tight raised sills or ramps at least 4 inches in height. An open-grated trench inside the room which drains to a safe location is a permissible alternative to a sill or ramp. General exhaust ventilation (either gravity or mechanical) which provides for a complete change of air within a room at least six times each hour is required. All lights, electrical equipment, and wiring must be of the type approved for hazardous locations.

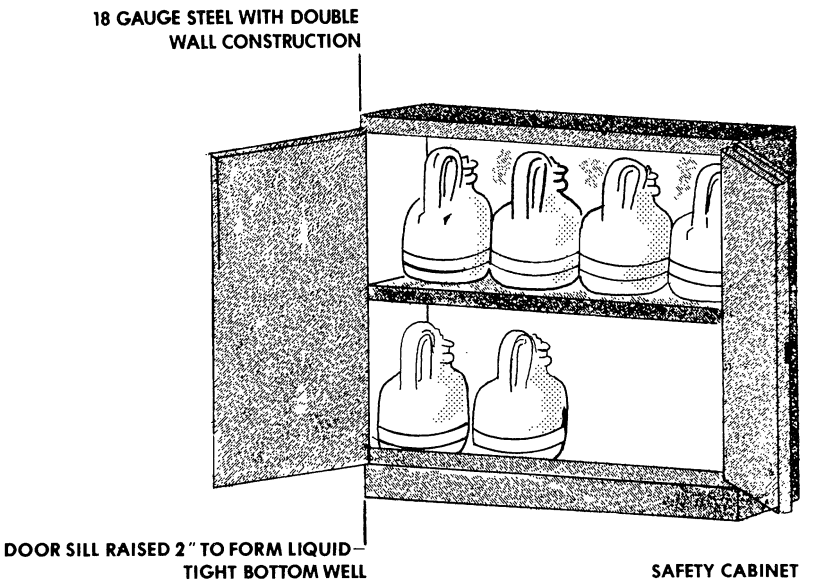
A fire extinguisher must be available (12 B minimum) located within 10 feet of the door.

Outside Storage Areas

If flammable and combustible liquids are stored outside, the storage area must be graded to divert spills away from buildings. The storage area must be posted as a "NO SMOKING" area, and must be kept free of weeds, debris, and other combustible material. There must be a fire extinguisher available at the storage area.

LPG Storage Areas

LPG storage tanks must be guarded to protect them from vehicular damage. The tank area must be posted "NO SMOKING" and there must be a fire extinguisher available in the area. Engines on vehicles must be shut down while being fueled.



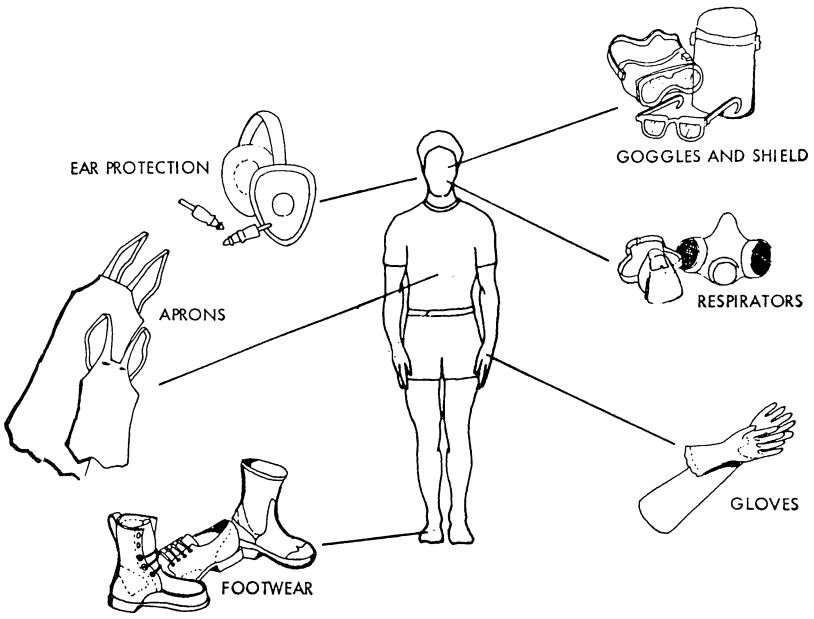
An approved metal storage cabinet

personal protective equipment

General Requirements

Personal protective equipment is required whenever there are hazards that can do bodily harm through absorption, inhalation, or physical contact. This equipment includes protective devices for the eyes, face, head, and extremities, protective clothing, and respiratory protection.

All personal protective equipment must be of safe design and reliable condition.



Eye and Face Protection

Eye protection and/or face shields are required where there is a possibility of any injury from flying particles, chips, sparks, and splashes

from liquids such as caustics, solvents, and hot or molten metals. Employees must wear this equipment when they use grinders, power drills, or other equipment which produces dust and chips.

Eye and face shields must be designed to provide adequate protection against the particular hazards to which the employee is exposed. The equipment must be easy to clean and be capable of being disinfected. If goggles must be worn by employees who wear glasses, the goggles must fit over the glasses, or corrective lenses can be mounted behind the protective lenses.

Gloves

When handling hazardous liquids, resins, acids, or other hazardous materials, employees must wear gloves which are impervious to such materials. The gloves must be long enough to protect the forearms. A decision regarding the use of a glove type for specific applications should be made in consultation with the supplier. The following table suggests glove types for exposure to the listed substances:

CHEMICAL	NEO-PRENE	NATURAL RUBBER OR LATEX	POLY-VINYL ALCOHOL	BUNA-N	POLY-D	VINYL
Animal oils	E	F	E	E	E	G
Degreasing fluids	F	P	E	G	E	P
Epoxy resins, dry	E	E	E	E	E	E
Hydraulic oil:						
Petroleum base	G	P	E	E	E	F
Ester base	E	P	G	G	G	P
Inorganic salts	E	E	F	E	E	G
Isopropyl alcohol	E	E	F	E	E	G
Lacquer thinners	G	F	E	G	F	F
Mercury	G	G	P	P	E	P
Nitric acid	G	F	NR	F	F	F
Paint thinners	G	F	E	G	G	F
Petroleum spirits	E	F	E	E	G	P
Phosphoric acid	E	G	P	E	E	G
Potassium hydroxide	E	E	P	E	E	G
Sodium hydroxide	E	E	P	E	E	G

KEY: E = excellent; G = good; F = fair; P = poor; NR = not recommended

CHEMICAL	NEO-PRENE	NATURAL RUBBER OR LATEX	POLY-VINYL ALCOHOL	BUNA-N	POLY-D	VINYL
Stoddard solvent	E	F	E	E	G	F
Sulfuric acid	G	G	P	G	F	F
Toluene	F	P	E	E	G	P
Trichloroethylene	F	P	E	F	G	P
Xylene	P	P	E	E	G	P

KEY: E = excellent; G = good; F = fair; P = poor; NR = not recommended

Head Protection

Protective head covering (hard hat) is required in situations where workers may be struck in the head by falling or flying objects.

Foot Protection

Safety shoes are recommended to prevent injury to the feet from falling objects and other hazards. They should be worn particularly where heavy stock is handled. They should also be worn where there are parts-handling, shipping, or receiving operations. In areas which may be slippery (e.g., battery charging and acids areas), appropriate footwear which provides good traction, such as rubber boots, shall be provided.

Aprons

When aprons are used as protection from acids and other hazardous materials, the apron must be impervious to such materials.

Coveralls, Caps, etc.

Under special conditions (e.g., dusty operations) a complete change of outer clothes may be necessary at the end of a shift. Coveralls, caps, and other types of clothing (rubber suits, etc.) should be worn while working. This clothing should be discarded at the end of the shift in appropriate hampers and the employee should change to street clothes

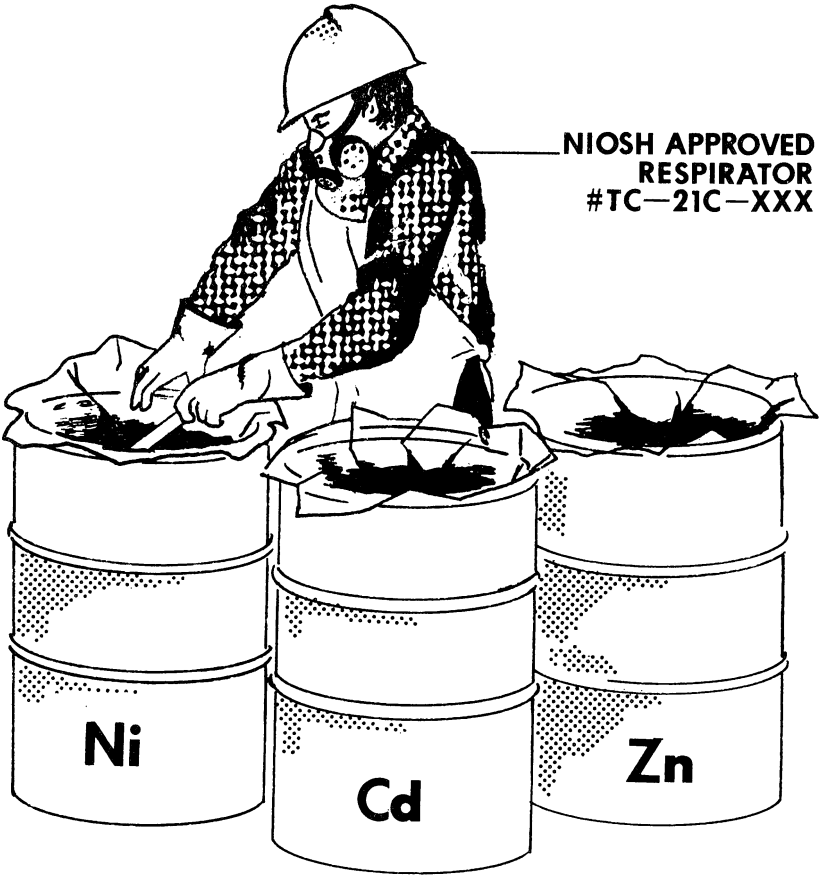
(after a shower, if necessary). It may also be necessary to have a separate laundry facility or have the clothing sent to a commercial laundry.

Respiratory Protection

NIOSH-approved respirators must be provided by the employer when air is contaminated with harmful dusts, fumes, mists, gases, or vapors. **Respiratory protection is not to be used as a substitute for feasible engineering or administrative control.** If these methods are not feasible, or while these controls are being implemented, use of respirators is permitted.

When respirators are used, a respirator program must be established:

- Respirators must be selected which are designed to protect against the specific hazards to which the worker is exposed.
- Written instructions covering selection and use of respirators must be available.
- Employees must be trained in the use of respirators, their limitation, proper fitting, and maintenance.
- Respirators should be cleaned at the end of each day's use. They should be taken apart, washed, dried, and defective parts replaced.
- Two people should never wear the same respirator unless it has been cleaned and disinfected between use.
- All straps should be tied and adjusted.
- A good face seal is necessary. Beards, sideburns, and glasses may interfere.
- Filters should be replaced when the respirator has been used for the specified lifetime of the cartridge, when an employee can smell vapors in the mask, or when breathing becomes difficult.

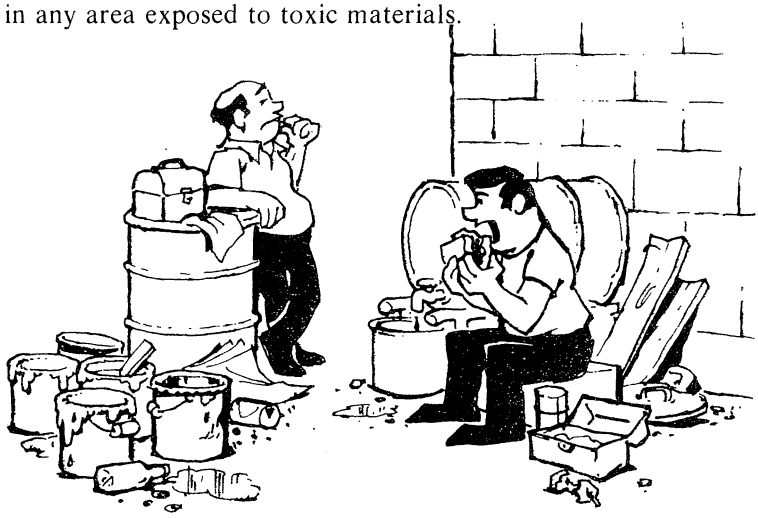


Working with an approved respirator

sanitation

- Safe drinking water must be provided in all places of employment. The use of a common drinking cup is forbidden.
- Receptacles for waste food must be covered and kept in a clean and sanitary condition.
- Restrooms must be kept in a clean and sanitary condition.
- Separate toilet facilities must be provided for each sex. If only one person at a time uses a toilet room and the door can be locked from the inside, separate facilities are not required.

- One toilet and one lavatory must be provided for approximately every 15 employees.
- Each lavatory must have hot and cold or tepid running water, hand soap, and individual hand towels or warm air blowers.
- Beverages or food must not be stored or consumed in a toilet room or in any area exposed to toxic materials.



- Employees working with toxic substances should wash and, where necessary, change from contaminated clothing before eating, drinking, or smoking.

medical and first aid

An important part of the company safety and health activity is a medical and first aid program. This program can help prevent lost work time and achieve good morale among employees. Medical personnel must be readily available—by phone or in the plant—for advice and consultation on employee health matters. A good policy is to require a medical examination before hiring and placement to ensure that prospective employees are physically able to do their specific job, and to determine if employees have some medical problem which could be aggravated by the assigned work. Periodic health evaluations for hazardous jobs and early treatment of any illness or injury should also be encouraged.

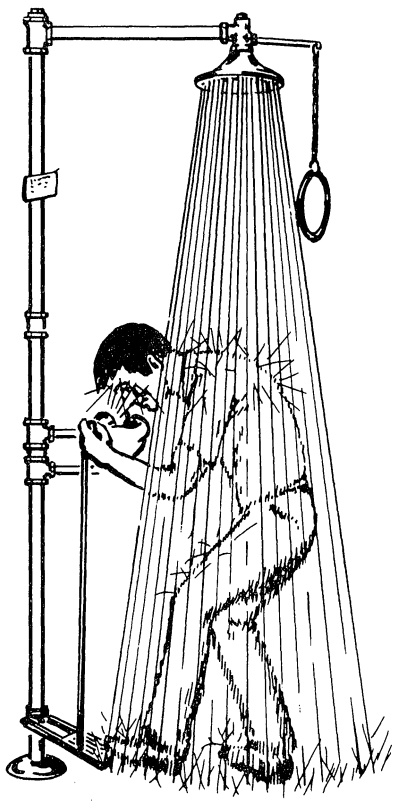
Hospital emergency phone numbers must be posted near telephones.

The Emergency Information Chart (printed inside the back cover of this guide) may be helpful. Stretchers and blankets should be available to transport injured or ill employees to a hospital.

If no infirmary, clinic, or hospital for the treatment of all injured employees is located in near proximity to your plant, the following are required:

At least one and preferably more employees on each shift must be trained in first aid. The American Red Cross, the U.S. Bureau of Mines, some insurance carriers, local safety councils, and others with OSHA-approved programs provide acceptable training.

First aid supplies approved by a consulting physician must be readily available. The supplies should be in sanitary containers with individually sealed packages for material such as gauze, bandages, and dressings that must be sterile. Other items often needed are adhesive tape, triangular bandages (to be used as slings), inflatable plastic splints, scissors, and mild soap for cleansing of wounds or cuts.



Suitable facilities for quickly drenching or flushing the eyes and body must be provided within the work area when a person may be exposed to corrosive material.

Some states have laws concerning medical practice which establish limits on first aid given by the lay person. Trained employees should understand where first aid ends and actual medical treatment begins.

First aid is immediate, temporary treatment given in the event of accident or illness—before the doctor arrives. **Immediate first aid (within four minutes) may prevent death or permanent impairment, and may lead to complete recovery.**

Emergency and First Aid Procedures for Lead Exposure

Eye exposure: If solids or liquids containing inorganic lead compounds get into the eyes, they should be washed immediately with large amounts of water, the lower and upper lids being lifted occasionally. If irritation persists after washing, the injured person should get medical attention. Contact lenses should not be worn when working with inorganic lead compounds.

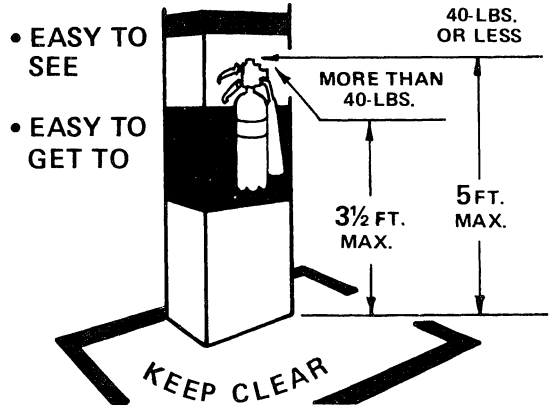
Skin exposure: If powdered lead or solids or liquids containing inorganic lead compounds get onto the skin, the contaminated area should be flushed promptly with soap or mild detergent and water. If powdered lead or solids or liquids containing inorganic lead compounds penetrate clothing, the clothing should be removed promptly and the skin washed with soap or mild detergent and water. If irritation is present after washing, the injured person should get medical attention.

Inhalation: If any person breathes in large amounts of lead or inorganic lead compounds, he should be moved to fresh air at once. If breathing has stopped, artificial respiration will be necessary. The affected person should be kept warm and at rest. Medical help should be sought as soon as possible.

Swallowing: When powdered lead or solids or liquids containing inorganic lead compounds have been swallowed, large quantities of water should be given to the victim. After the water has been swallowed, the victim should make himself or be made to vomit by touching the back of his throat with a finger. **An unconscious person should not be made to vomit.** Medical attention should be sought for the victim as soon as possible.

Rescue: Established emergency rescue procedures and the location of emergency equipment should be known by all employees. The victim should be moved from the hazardous area, but rescue should not be attempted by one person alone. At least one other person should be available for the safety of the first rescuer.

fire extinguishers



Fire extinguishers must:

be kept fully charged and in their designated places;

be located along normal paths of travel;

not be obstructed or obscured from view;

not be mounted higher than five feet (to the top of the extinguisher) if 40 pounds or less. If heavier than 40 pounds, they must not be mounted higher than 3 1/2 feet;

be inspected by management or a designated employee at least monthly to insure that

- they are in their designated places,
- they have not been tampered with or actuated, and
- there is no corrosion or other impairments.

be examined at least yearly and recharged or replaced if necessary, to insure operability and safety. A tag must be attached to show the maintenance or recharge date and signature or initials of the person performing the service;

be hydrostatically tested. Extinguisher sales representatives usually will perform this service at appropriate intervals;

be selected on the basis of type of hazard, degree of hazard, and area to be protected. The following table will help in the selection.

Type of hazard	Basic minimum extinguisher rating	Maximum travel distance to extinguishers (feet)
Light	4B	50
Ordinary	8B	50
Extra	12B	50

Basic minimum extinguisher rating for area specified	Maximum travel distance to extinguishers (feet)	Areas to be protected per extinguisher		
		Light hazard occupancy (square feet)	Ordinary hazard occupancy (square feet)	Extra hazard occupancy (square feet)
1A	75	3,000	---------	---------
2A	75	6,000	3,000	Note 1
3A	75	9,000	4,500	3,000
4A	75	11,250	6,000	4,000
6A	75	11,250	9,000	6,000

be placed so that the maximum travel distances, unless there are extremely hazardous conditions, do not exceed 75 feet for Class A or 50 feet for Class B.

A chart showing fire extinguishers by class, and how to use them, is located in the back of this booklet.

automatic sprinkler systems

When automatic sprinkler systems are provided, they must meet design requirements of the National Fire Protection Association's Standard for the Installation of Sprinkler Systems (NFPA No. 13-1969). (OSHA requirements are extracted from the NFPA Standard.)

The following are important provisions of these requirements:

Every automatic sprinkler system must have at least one automatic water supply of adequate pressure, capacity, and reliability.

One or more fire department connections through which the fire department can pump water is required. No shut-off valve is allowed in this connection.

The employer is responsible for the condition of the sprinkler system and must keep it in good operating order. Functional tests are required at least once each year.

The clearance between sprinkler deflectors and the top of combustible storage normally must be at least 36 inches. If the material is in solid piles less than 15 feet high or in piles less than 12 feet high with horizontal channels, a minimum clearance of 18 inches is allowed. Also, commodities containing only small amounts of combustible material may be stored up to 18 inches from the sprinkler deflectors.

Alarm systems, audible to all employees, should be provided on all automatic sprinkler installations.

An elaboration of requirements pertaining to automatic sprinkler systems can be found in the General Industry Standards, 29 CFR 1910.159.

compressed air equipment

Employees should be familiar with the air compressor's operating and maintenance instructions.

New air tanks must be constructed in accordance with the American Society of Mechanical Engineers (A.S.M.E.) Boiler and Pressure Vessel Code, Section VIII. The A.S.M.E. Code requires this information to be permanently stamped on the air tank.

The drain valve on the air tank should be opened frequently to prevent excessive accumulation of liquid.

Air tanks must be protected by safety-relief valves. These valves must be tested at regular intervals to be sure they are in good operating condition. The pressure controller and gauge must be maintained in good operating condition. There must be no shut-off valves between the air tank and the safety valve.

materials handling and storage

Materials Handling — General

The storage of materials must not, of itself, create a hazard. Materials stored in tiers (bags, containers, bundles, pallets) must be stacked, strapped, blocked, or interlocked and limited in height so that they are stable and secure against sliding or collapse. Stored material must not obstruct fire extinguishers, alarm boxes, sprinkler system controls, electrical switch boxes, emergency lighting, first aid equipment, or exits.

All containers should be kept closed and drums sealed. If any leakage occurs, the damaged container must be removed and any fire or slipping hazard eliminated.

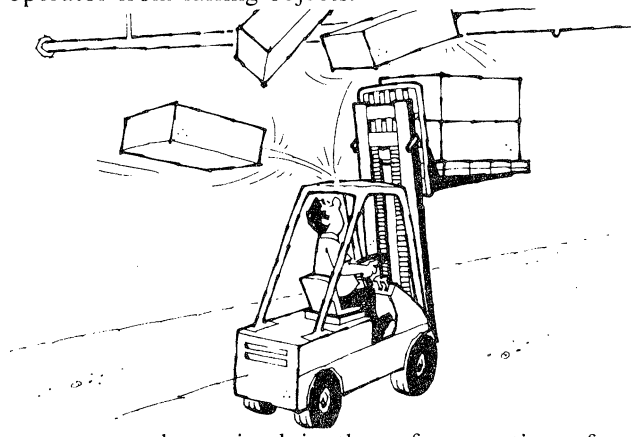
Aisles in the storage area must be kept free of obstructions and sufficient clearance maintained for foot and vehicular traffic. Where limited clearance exists (e.g., low overhead clearance), clearance limit warning signs must be posted. Proper drainage must be provided throughout the storage area.

Powered Industrial Trucks

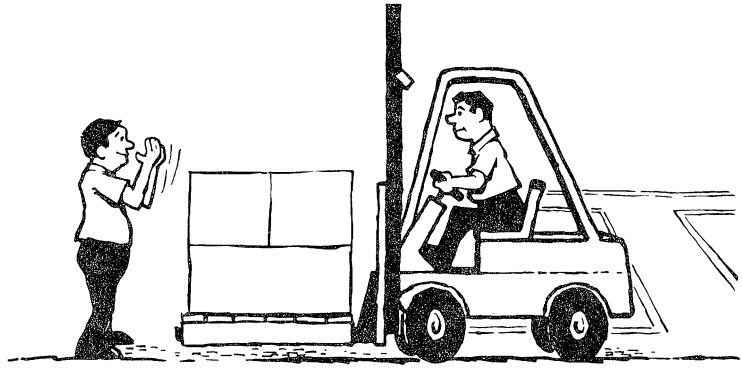
Powered industrial trucks are classified into categories for the purpose of determining what type of truck may be used in a certain location. The type of hazard in a location determines whether diesel, electric,

gasoline, or LP-gas powered trucks may be used and what additional safeguards must be present. Suppliers can assist in the proper selection.

High-lift rider trucks must be fitted with an overhead guard to protect the operator from falling objects.

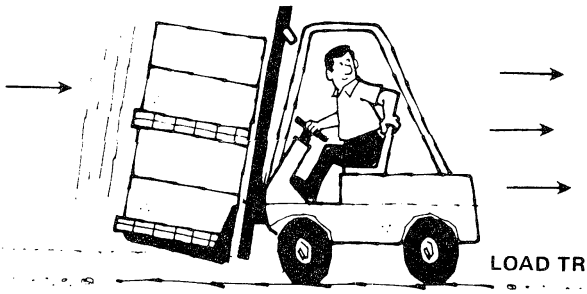


Operators must be trained in the safe operation of powered industrial trucks, and only trained and authorized employees may operate a truck. Truck manufacturers and suppliers may provide training courses.



When a powered industrial truck is left unattended (operator 25 feet or more away, or the truck is not in view), the forks must be fully lowered, the control lever position in neutral, the power shut off, and the brakes set. The wheels must be blocked if parked on an incline.

Industrial trucks must be examined daily for any conditions adversely affecting the safety of the vehicle before being placed into service. If the truck is used around the clock, it must be inspected after each shift.



If the load being carried obstructs forward view, the operator is required to travel with the load trailing.

When unloading or loading from trucks, trailers, or railroad cars with forklift trucks, provision must be made for securing the truck, trailer, or railroad car by setting the brakes and placing wheel chocks under the rear wheels. Portable dock boards must be secured in position with devices which will prevent their slipping during loading and unloading.

If battery-operated equipment is used, the battery charging area is to be designated with a "NO SMOKING" sign due to the hydrogen gas emitted during the charging process.

Hoists

Although the information provided in this section on hoists pertains specifically to cranes, these requirements should be applied to all hoisting equipment.

- The rated load must be legibly marked on each side of the hoist. Employees should be made aware of the weight of the load.
- The hoist must be equipped with a self-setting brake applied to the motor shaft or some part of the gear train.

- For powered hoists, holding brakes must be applied automatically when the power is off.
- Hooks, chains, and all functional operating mechanisms must be inspected daily for damage and wear, and monthly records of inspections maintained.
- Loads must not be carried over the heads of people.
- The operator must test the brakes each time a near-capacity load is handled. This test is done by raising the load a few inches and applying the brakes.
- The hoist rope or chain must be free from kinks or twists and not be wrapped around the load.

machinery and machine guarding

General Requirements for Machine Guarding

One or more methods of machine guarding must be provided to protect the operator and other employees in the machine area from hazards such as those created by the point of operation, in-running nip points, rotating parts, flying chips, and sparks. All such hazards located seven feet or less above the ground, floor, or working platform must be guarded to prevent accidental contact. Guards must be attached to the machine if possible, or secured elsewhere if attachment to the machine is not possible. The guard must prevent the operator from having any part of the body in the danger zone during the operating cycle of the machine. Guards must not offer an accident hazard in themselves. Machines designed for fixed locations must be securely anchored to prevent "walking" or tipping.

The most common methods of machine guarding are

- enclosing the operation (the preferred method)
- interlocking devices
- remote control
- two-hand tripping devices
- electronic safety devices
- removal devices
- moving barriers

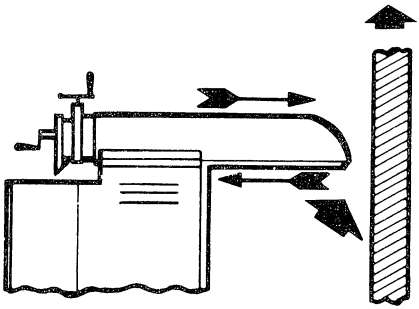
Certain guarding methods are preferable to others. The type of operation, the size and shape of stock, the method of handling stock, the physical layout, the type of material, and the production requirements or limitations are important considerations. A certain flexibility in operations may also determine the method to be used.

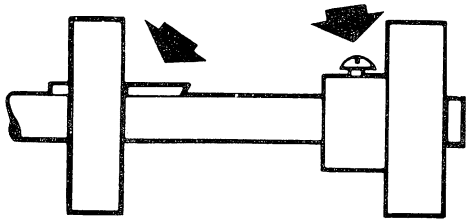
A booklet entitled "The Principles and Techniques of Mechanical Guarding", OSHA 2057, can be obtained by writing to OSHA Regional Offices listed in the back of this book. Many equipment representatives can assist in obtaining the necessary protective devices.

The following pages contain examples of specific equipment that must be guarded. This listing is not intended to include all equipment that may require guarding, nor are the guarding methods suggested the only ones that may be effective.

Rotating and Reciprocating Motion

Collars, couplings, cams, clutches, flywheels, shaft ends, spindles, lead screws, and horizontal or vertical shafting are typical examples of rotating mechanisms which are hazardous. The danger increases when bolts, oil cups, nicks, abrasions, and projecting keys or screw threads are exposed when rotating.

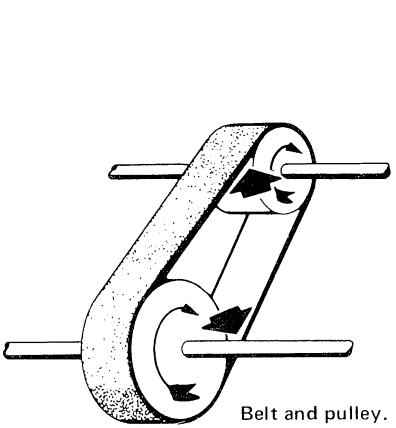




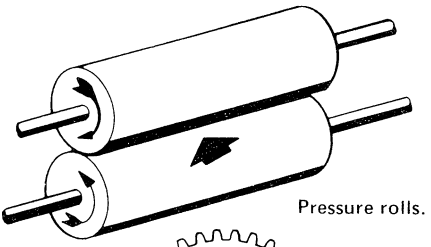
Rotating shaft and pulleys with projecting key and set screw

In-Running Nip Points

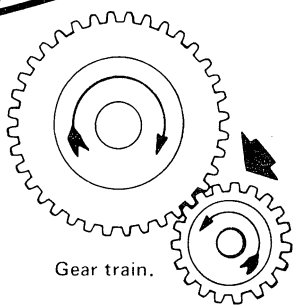
In-running nip points are a special danger created by the action of rotating objects. Whenever machine parts rotate toward each other or where one rotates toward a stationary object, an in-running nip point is formed. Objects or parts of the body may be drawn into this nip point and be bruised or crushed. Gears, feed rolls, conveyor terminals, forming rolls, and printing press rolls are examples of nip points.



Belt and pulley.



Pressure rolls.

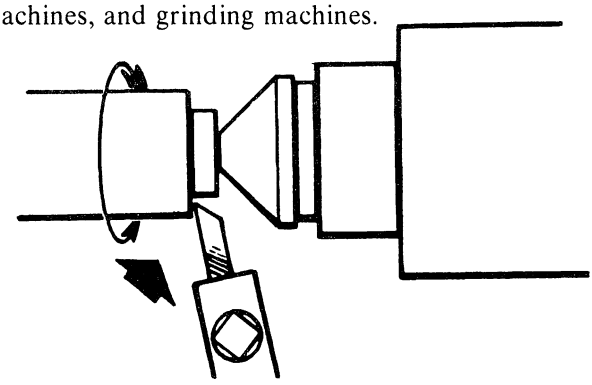


Gear train.

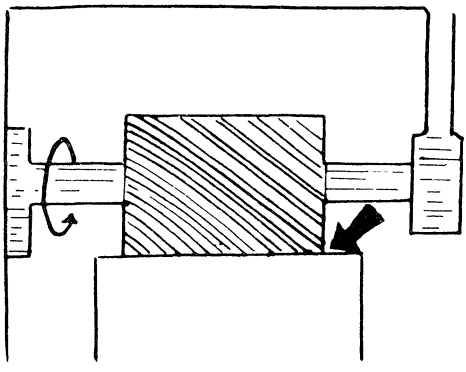
Cutting Actions

Cutting action results when rotating, reciprocating, or transverse motion is imparted to a tool so that the material removed is in the form of chips. The danger of cutting action exists at the movable cutting edge of the machine as it approaches or comes in contact with the material being cut. Such action takes place at the point of operation in cutting wood, metal, or other materials as differentiated from punching, shearing, or bending by press action.

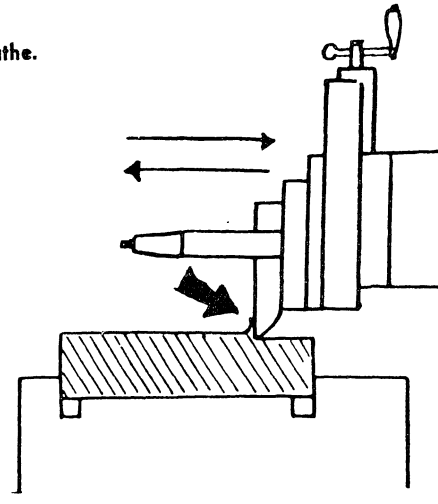
Typical examples of cutting action are band and circular saws, milling machines, planing or shaping machines, turning machines, boring or drilling machines, and grinding machines.



Engine lathe.



Milling machine.

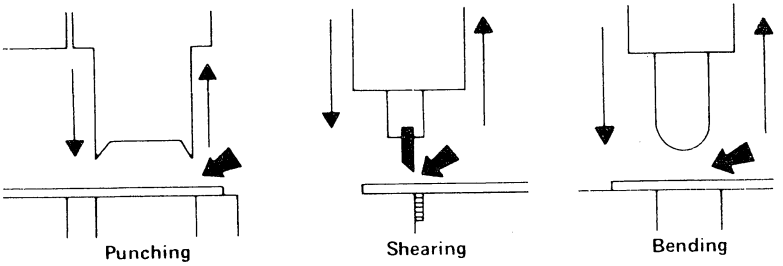


Shaper.

Punching, Shearing, and Bending Action

Punching, shearing, or bending action results when power is applied to a ram (plunger) or knife for the purpose of blanking, trimming, drawing, punching, shearing, or stamping material as differentiated from removing the material in the form of chips. The danger of punching, shearing, or bending action lies at the point of operation where stock is actually inserted, held, and withdrawn.

Typical examples of equipment involving punching, shearing, or bending action include power presses, shears, embossing presses, and stamping presses.



Classification of Guards

The methods of machine guarding may be grouped under four main classifications: enclosure, interlocking, and automatic guards, and two-handed operating devices.

Enclosure Guards

Fixed enclosure guards are preferred to all other types. They always prevent access to dangerous parts by completely enclosing a hazardous operation, and can also be effective in controlling dust or chips generated by the operation. Because of limited feed-size openings, enclosure guards admit stock, but will not admit an employee's hand into the danger zone. They may be constructed so as to be adjustable to different sets of tools and dies or varying thicknesses of stock, but once adjusted, they must be fixed. As a general rule, power transmission apparatus can be protected by enclosure guards.

Interlocking Guards

When a fixed enclosure guard is not practicable, an interlocking enclosure or barrier should be considered as the first alternative.

An interlocking enclosure guard is not fixed; it may be opened to feed stock and adjusted as the operation requires. These guards use an electrical or mechanical interlock with the operating mechanism which prevents the operation of the machine until the guard is returned to a closed position and the operator can no longer reach the point of danger.

Automatic Guards

When neither an enclosure guard nor an interlocking guard is practicable, an automatic guard may be used. An automatic guard acts independently of the operator, repeating its cycle as long as the machine operates. This type of guard removes the operator's hands, arms, or body from the danger zone as the machine cycles. It is operated by the machine itself through a system of linkages connected to the operating mechanism.

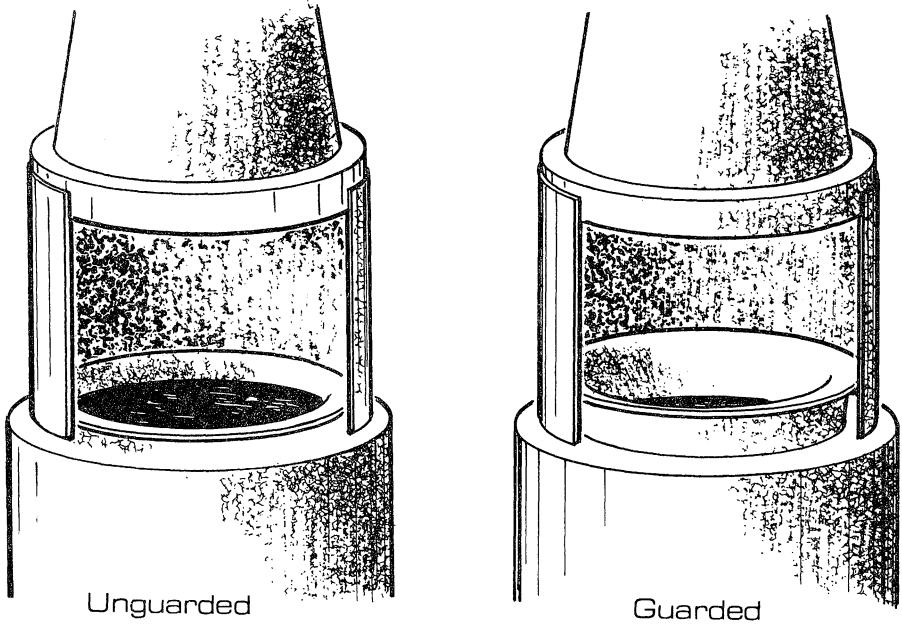
Common types of automatic guards are sweep and push-away devices which create a moving barrier across the danger zone and push the operator's hand away from the area.

Two-Handed Operating Devices

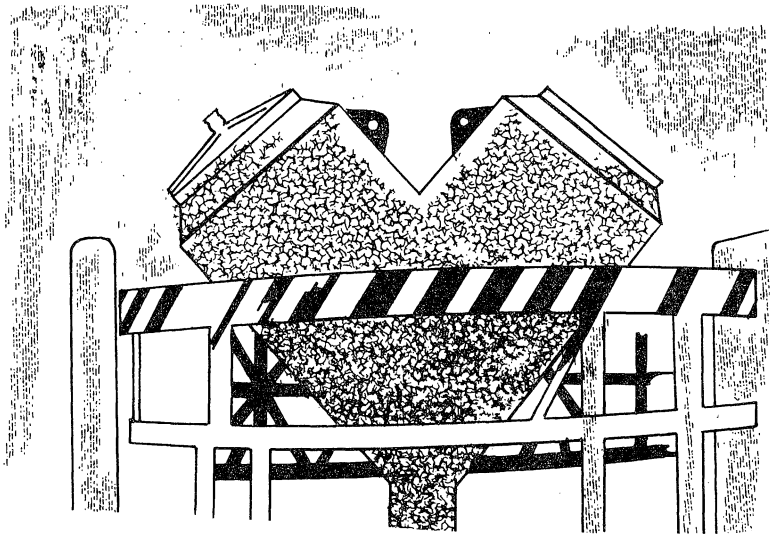
Two-handed operating devices, another category of guarding mechanism, are also designed to protect a machine operator from point of operation hazards. Although they are not guards in the technical sense, they accomplish the same effect.

These devices may be used to activate the machine cycle. They require simultaneous action of the operator's hands on electrical switch buttons, air control valves, mechanical levers, etc. The actuating controls must be located so as to make it impossible for the operator to move his hands from the controls to the danger zone before the machine has completed its closing cycle. The two-handed controls must be so designed as to prevent the blocking, tying down, or holding down of one control to allow one hand free access to the danger zone.

The following are examples of guarding:



Splash guard (on molten metal pot)



Barrier guard (on rotating equipment)

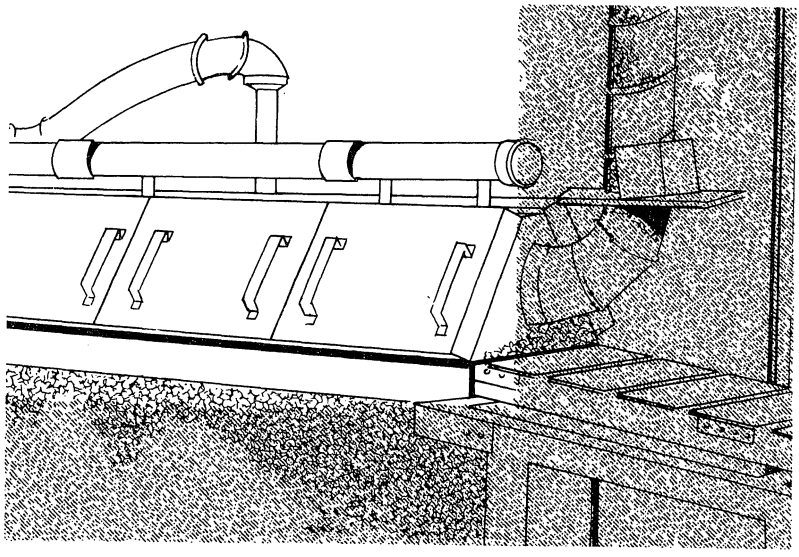


Plate guard (covers in-running nip point)

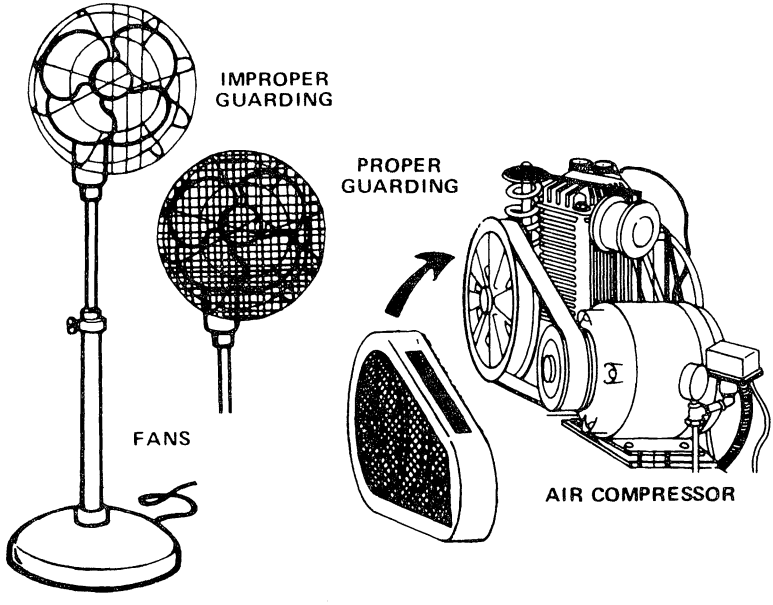
Grinders

Wheel safety guards must cover the spindle end, nut, and flange projections. The exposed area of the grinding wheel should not exceed one-fourth of the area of the entire wheel. When the guard opening is measured, the visors and other accessory equipment are not included as part of the guard unless they are as strong as the guard.

Work or tool rests must be of strong construction and must be adjustable to compensate for wheel wear. Work rests must be kept closely adjusted to the wheel to prevent the work from becoming jammed between the wheel and the work rest. The maximum clearance allowed is 1/8 inch.

Tongue guards (upper peripheral guards) must be constructed so that they adjust to the wheel as it wears down. A maximum clearance of 1/4 inch is allowed between the wheel and the tongue guard.

Goggles or a face shield must be worn by grinder operators.



Fans

If fans are located within 7 feet of the floor, they must be guarded with grille or mesh, limiting openings to not more than 1/2 inch (least dimension).

Air Compressors

The pulleys and drive belts of air compressors must be fully enclosed.

hand and portable powered tools

The following is a list of general requirements governing the use of hand tools:

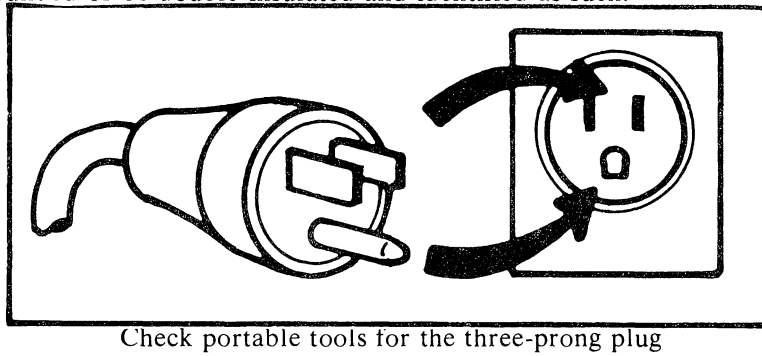
Each employer is responsible for the safe condition of tools and equipment used by employees, including tools and equipment which may be furnished by employees.

Hammers with broken or cracked handles, chisels and punches with mushroomed heads, wrenches with sprung jaws, and bent or broken wrenches should not be used.

Most hand-held electrical tools must be equipped with a "dead man" or "quick release" control, so that power is shut off automatically whenever the operator releases the control.

Portable circular saws must be equipped with guards above and below the base plate or shoe. The lower guard must retract when the blade is in use, and automatically return to the guarding position when the tool is withdrawn from the work.

All hand-held portable electrical equipment must have its frame grounded or be double-insulated and identified as such.



Check portable tools for the three-prong plug

All tools must be used with appropriate shields, guards, and attachments and in accordance with recommendations by the manufacturers. Employees must be trained in the use of power tools and safety requirements.

The rated load of any jack must be permanently marked on the jack.

Jacks must be inspected for wear and general condition at least once every six months.

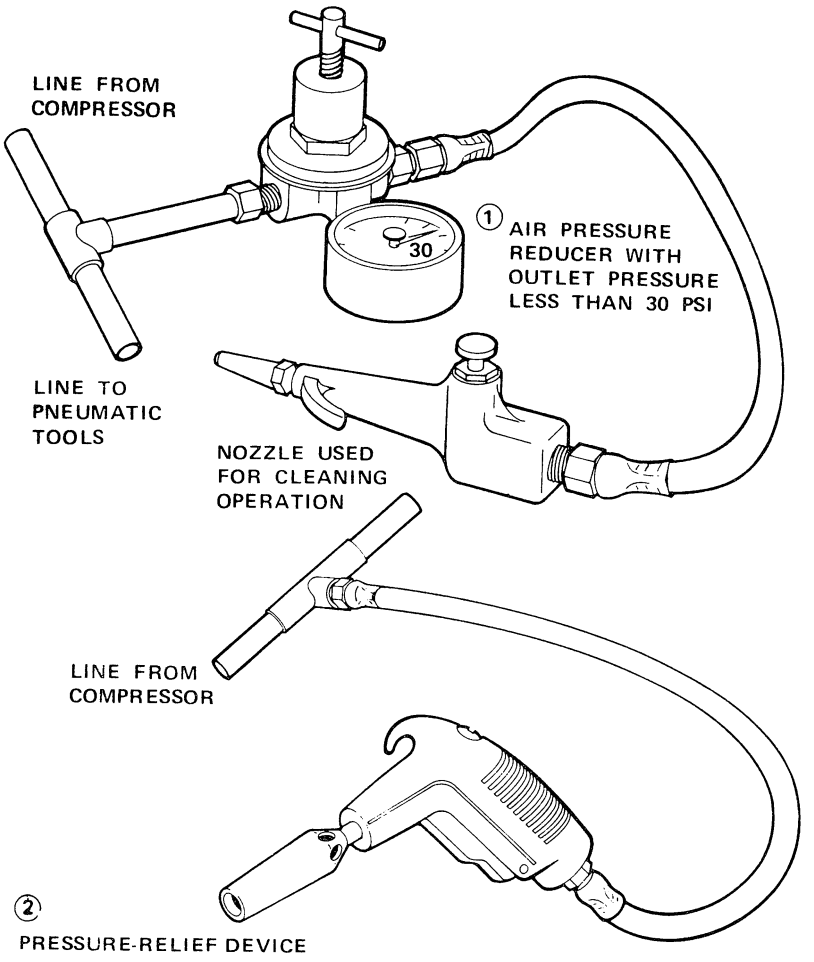
Jacks must be appropriately blocked or cribbed when necessary to provide a firm foundation.

Pneumatic power tools must be positively secured to the hose to prevent the tool from becoming disconnected. A tool retainer must be used on tools to prevent the attachment from being expelled.

Nailers, staplers, and similar equipment with automatic feed should have a muzzle to prevent the tool from ejecting a piece unless the muzzle is in contact with a work surface.

Compressed Air Equipment

Beware of compressed air—it can be dangerous. Alternate methods of cleaning surfaces should be sought. Compressed air must never be used to blow debris from a person. Compressed air may be used for cleaning surfaces if there is no other acceptable method. The downstream pressure of compressed air must remain below 30 psi whenever the nozzle is dead-ended. Effective chip guarding and personal protective equipment must be used. Two acceptable methods of meeting the 30-psi requirement are illustrated.



welding, cutting, and brazing

General Requirements

Management must establish areas for cutting and welding operations based on the fire potentials of the plant. Special procedures must be established for welding and cutting in high hazard locations. Preferably, cutting or welding should be done in an area with no surrounding combustible material. If combustibles in the immediate vicinity are unavoidable, guards must be used to protect against the fire hazards from heat and sparks. Suitable fire extinguishing equipment (pails of water, buckets of sand, a hose, or a portable extinguisher) must be maintained for instant use.

Torch cutters and welders must be trained in the safe operation of their equipment. Printed rules and instructions (supplied by the manufacturers) covering operation of equipment must be strictly enforced.

No welding, cutting, or other hot work may be performed on used drums, barrels, tanks, or other containers until they have been cleaned so thoroughly it is absolutely certain that there are no traces of flammable

materials or substances which, when subjected to heat, might produce flammable or toxic vapors.

The atmosphere in the welding area must be free of flammable gases, liquids, and vapors.

Goggles or other suitable eye protection (e.g., helmets) must be used during welding or cutting operations as a protection against sparks and debris.

Employees adjacent to the welding areas must be protected from ultraviolet rays by noncombustible or flameproof screens or shields, or they must be required to wear appropriate goggles.

Employees exposed to hazards created by cutting and welding must wear personal protective equipment. For example:

- flameproof gauntlet gloves (except when engaged in light work) should be worn;
- flameproof aprons (leather, for example) may be desirable as protection against sparks and radiant heat;
- fire resistant leggings or high boots should be worn.

The potential health hazard to a welder or cutter from gases or metal fumes depends on the toxicity of the materials involved (types of metals, fluxes, coatings, etc.), the duration and location of the process, and ventilation.

There are specific requirements concerning ventilation and respirators when welding or cutting is performed on:

- stainless steel, lead, zinc, or cadmium
- metals coated with lead or mercury-containing materials such as paint
- fluxes or other materials containing fluorides.

These requirements are summarized here.

Welding or Cutting on Materials Containing or Coated With	*Location of Operation*		
	Confined Spaces	*Indoors*	*Outdoors*
Lead	A	B	E
Zinc	A	B	
Fluorine	A	C	C
Cadmium	C	C	F
Beryllium	D	D	D
Mercury	C	C	F

Stainless Steel = mechanical ventilation adequate to remove the fumes generated.

A = Adequate ventilation to prevent the accumulation of toxic fumes or possible oxygen deficiency. Where it is impossible to provide such ventilation, approved airline respirators must be used.

B = Mechanical local exhaust by means of hoods or booths with sufficient airflow to maintain a velocity, away from the worker, of at least 100 linear feet per minute.

C = If conditions warrant, mechanical local exhaust (B) *or* approved airline respirators.

D = If conditions warrant, mechanical local exhaust (B) *and* approved airline respirators.

E = Approved respirators.

F = If conditions warrant, approved respirators (E).

Mechanical ventilation must be provided when welding or cutting is done on metals not covered in the table when

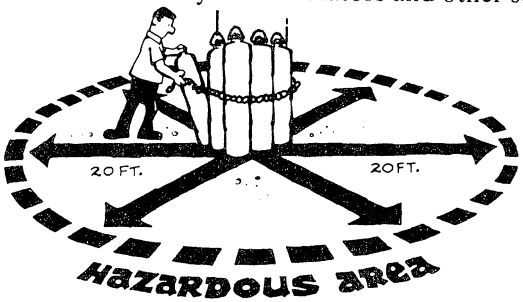
- the volume of space per welder is less than 10,000 cubic feet, or
- the ceiling is less than 16 feet high, or
- work is done in confined spaces.

Such mechanical ventilation must be at the minimum rate of 2,000 cubic feet per minute per welder, unless hoods or booths are provided with sufficient airflow to maintain a velocity, away from the worker, of at least 100 linear feet per minute. Alternatively, NIOSH-approved supplied-air respirators must be used.

Gas Welding

General requirements governing gas welding:

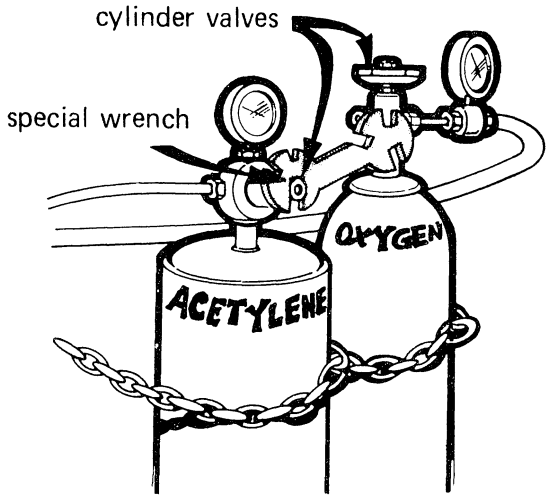
All cylinders must be away from radiators and other sources of heat.



All cylinders stored inside buildings must be located in a well-protected, well-ventilated, dry location at least 20 feet from highly combustible materials and away from elevators, stairs, or gangways. They must not be kept in unventilated enclosures, such as lockers and cupboards.

Valve protection caps must be used where the cylinder is designed to accept a cap except when cylinders are in use or connected for use.

Stored oxygen cylinders must be kept separated from stored fuel gas cylinders or combustible materials (especially oil or grease) by a minimum distance of 20 feet or by a non-combustible barrier at least 5 feet high and having a 1/2-hour fire resistance rating. A sheet metal partition is not an acceptable method of separating cylinders.

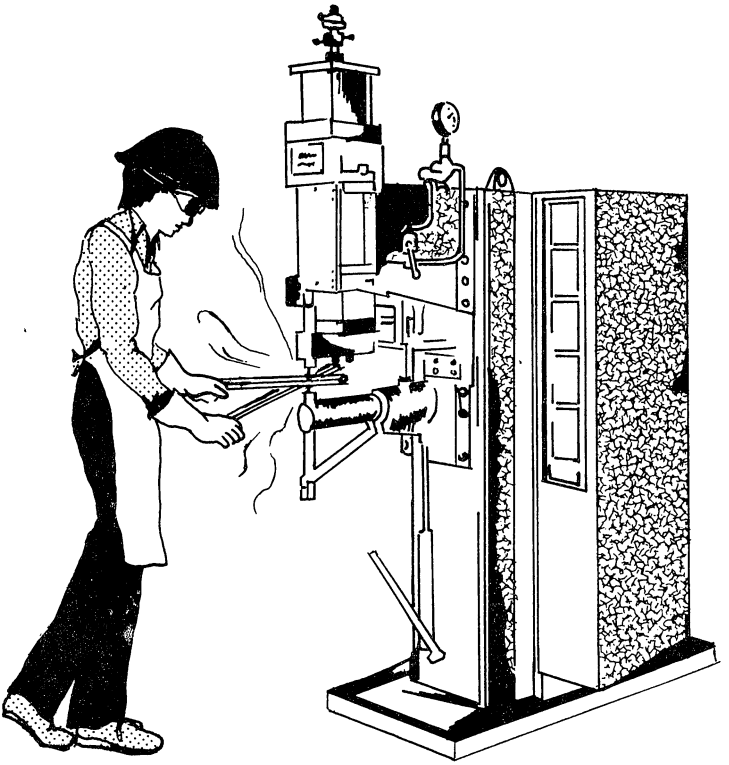


All cylinder valves must be closed when work is finished. Where a special wrench is required, it must be left in position on the stem of the valve while the cylinder is in use so that the fuel-gas flow can be quickly turned off in case of emergency. In the case of manifolded or coupled cylinders, at least one such wrench must always be available for immediate use.

All cylinders must be legibly marked to identify contents.

No cylinder should be permitted to stand alone without being secured with lashing or chain to prevent it from toppling over.

Acetylene must not be used at a pressure in excess of 15 psi gauge (or 30 psi absolute). Above this pressure, acetylene may become unstable.



Spot welding can release small quantities of fume

Indoor storage of fuel gas is limited to a total capacity of 2,000 cubic feet or 300 pounds of liquified petroleum gas.

Hoses showing leaks, burns, or worn places which make them unfit for service must be replaced or repaired.

Electric Arc Welding

Wherever electric arc welding is done, it is required that:

- if the welding machine is wet, it must be thoroughly dried and tested before it is used again;
- coiled welding cable must be spread out and the ground lead must be firmly attached to the work;
- cables must be inspected for damage and loss of insulation and be repaired immediately;
- ground and electrode cables may only be joined together with connectors specifically designed for that purpose;
- cables with splices within 10 feet of the operator may not be used, nor may the operator coil cables around his body;
- welding helmets must be worn by the operator and persons close by must wear eye protection;
- shields or screens must protect others in the vicinity from arc welding rays;
- arc welders should wear clean, fire-resistant gloves and clothing, with collars and sleeves buttoned;
- electrode holders which are not in use must be placed in a safe place away from conductive objects.

the national electrical code (nec)

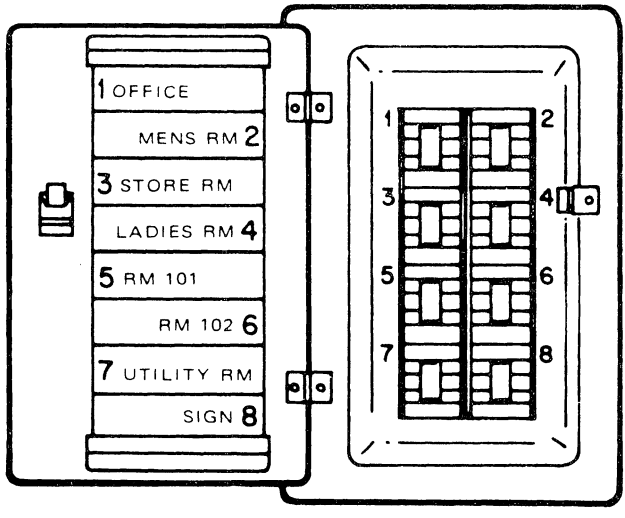
Electrical Requirements

More fires are caused by electrical malfunction than any other cause, and standards pertaining to electrical equipment and its use in all industries have been cited as violations more frequently than any others.

The National Electrical Code (NFPA 70-1971; ANSI C1-1971) has been adopted as a national consensus standard by OSHA (refer to "Information Sources"). The purpose of the NEC is the practical safeguarding of persons, and buildings and their contents from hazards arising from

the use of electricity. The code contains minimum provisions considered necessary for safety. Your electrician or maintenance personnel should be familiar with these requirements:

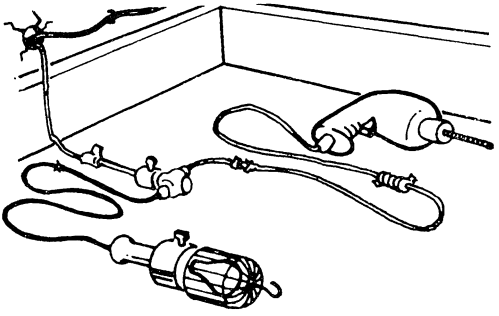
- Each disconnecting means (e.g., circuit breaker or fuse box) must be legibly marked to indicate its purpose, unless its purpose is evident.



Proper labelling of circuit breakers

- Frames of electrical motors, regardless of voltage, must be grounded.
- Exposed noncurrent-carrying metal parts of fixed equipment that may become energized under abnormal conditions must be grounded under any of the following circumstances:
  —in wet or damp locations;
  —if in electrical contact with metal;
  —if operated in excess of 150 volts to ground;
  —when in a hazardous location.

- Exposed noncurrent-carrying metal parts of the following equipment, which are liable to become energized, must be grounded or double-insulated and distinctly marked:
  —portable hand-held motor-operated tools;
  —appliances;
  —any equipment operated in excess of 150 volts to ground.
- Outlets, switches, junction boxes, etc., must be covered.



Misuse of flexible cords

- Flexible cords may not be:
  —used as a substitute for fixed wiring;
  —run through holes in walls, ceilings, or floors;
  —run through doors, windows, etc.;
  —attached to building surfaces.
- Flexible cord must be fastened so that there is no pull on joints or terminal screws. It must be replaced when frayed or when the insulation has deteriorated.
- All splices in flexible cord must be brazed, welded, or soldered or joined with suitable splicing devices. Any splices, joints, and free ends of conductors must be properly insulated.

recordkeeping requirements

Recordkeeping requirements under OSHA call for factual information about accidents. Employers can use these records to evaluate the success of their safety and health activities and to identify high risk areas of their businesses to which attention should be directed. Employers must report within 48 hours to OSHA (or a state agency in states which have operational safety and health plans) any incident or accident which results in hospitalization of five or more employees or a fatality.

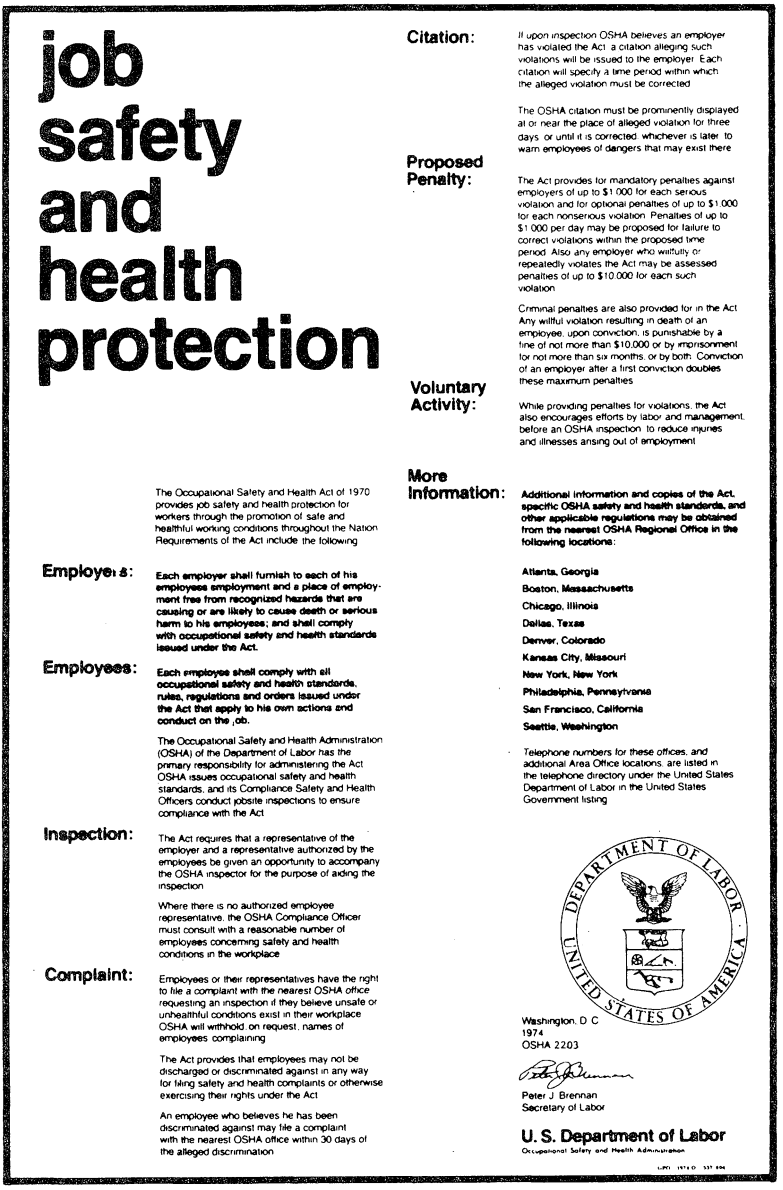
Federal regulations require that employers with 11 or more employees at any time during the preceding calendar year complete OSHA Forms 100, 101 (or equivalent), and 102. The following cases must be recorded on the OSHA Form 100 (Log of Occupational Injuries and Illnesses): every death, every illness, and any injury which results in loss of consciousness, loss of time, restriction of work or motion, temporary or permanent transfer to another job, or medical treatment other than first aid. Illnesses and injuries are classified as to lost workdays, restriction of duties or "light duty", and no lost time.

A supplementary record must be completed for each recordable case. OSHA Form 101 may be used; a state workers' compensation report or other form is acceptable if it contains the equivalent information as the OSHA 101. Forms 100 and 101 must be kept current to within six days.

An annual summary, OSHA Form 102, must be posted for the entire month of February in a place where all employees are likely to see it. All of these forms (100, 101, and 102) must be retained for five years, excluding the current calendar year.

A booklet, "Recordkeeping Requirements Under the Williams-Steiger Occupational Safety and Health Act of 1970", provides a supply of forms and more detailed information. It is available from OSHA regional or area offices or from the regional offices of the Bureau of Labor Statistics.

The employer should consult with the state occupational safety and health agency (if the state has an approved program) to determine what records are required by the state.



job safety and health protection

The Occupational Safety and Health Act of 1970 provides job safety and health protection for workers through the promotion of safe and healthful working conditions throughout the Nation. Requirements of the Act include the following:

Employers: **Each employer shall furnish to each of his employees employment and a place of employment free from recognized hazards that are causing or are likely to cause death or serious harm to his employees; and shall comply with occupational safety and health standards issued under the Act.**

Employees: **Each employee shall comply with all occupational safety and health standards, rules, regulations and orders issued under the Act that apply to his own actions and conduct on the job.**

The Occupational Safety and Health Administration (OSHA) of the Department of Labor has the primary responsibility for administering the Act. OSHA issues occupational safety and health standards, and its Compliance Safety and Health Officers conduct jobsite inspections to ensure compliance with the Act.

Inspection: The Act requires that a representative of the employer and a representative authorized by the employees be given an opportunity to accompany the OSHA inspector for the purpose of aiding the inspection.

Where there is no authorized employee representative, the OSHA Compliance Officer must consult with a reasonable number of employees concerning safety and health conditions in the workplace.

Complaint: Employees or their representatives have the right to file a complaint with the nearest OSHA office requesting an inspection if they believe unsafe or unhealthful conditions exist in their workplace. OSHA will withhold, on request, names of employees complaining.

The Act provides that employees may not be discharged or discriminated against in any way for filing safety and health complaints or otherwise exercising their rights under the Act.

An employee who believes he has been discriminated against may file a complaint with the nearest OSHA office within 30 days of the alleged discrimination.

Citation: If upon inspection OSHA believes an employer has violated the Act, a citation alleging such violations will be issued to the employer. Each citation will specify a time period within which the alleged violation must be corrected.

The OSHA citation must be prominently displayed at or near the place of alleged violation for three days, or until it is corrected, whichever is later, to warn employees of dangers that may exist there.

Proposed Penalty: The Act provides for mandatory penalties against employers of up to $1,000 for each serious violation and for optional penalties of up to $1,000 for each nonserious violation. Penalties of up to $1,000 per day may be proposed for failure to correct violations within the proposed time period. Also, any employer who willfully or repeatedly violates the Act may be assessed penalties of up to $10,000 for each such violation.

Criminal penalties are also provided for in the Act. Any willful violation resulting in death of an employee, upon conviction, is punishable by a fine of not more than $10,000 or by imprisonment for not more than six months, or by both. Conviction of an employer after a first conviction doubles these maximum penalties.

Voluntary Activity: While providing penalties for violations, the Act also encourages efforts by labor and management, before an OSHA inspection, to reduce injuries and illnesses arising out of employment.

More Information: **Additional information and copies of the Act, specific OSHA safety and health standards, and other applicable regulations may be obtained from the nearest OSHA Regional Office in the following locations:**

Atlanta, Georgia
Boston, Massachusetts
Chicago, Illinois
Dallas, Texas
Denver, Colorado
Kansas City, Missouri
New York, New York
Philadelphia, Pennsylvania
San Francisco, California
Seattle, Washington

Telephone numbers for these offices, and additional Area Office locations, are listed in the telephone directory under the United States Department of Labor in the United States Government listing.

DEPARTMENT OF LABOR · UNITED STATES OF AMERICA

Washington, D.C.
1974
OSHA 2203

Peter J. Brennan
Secretary of Labor

U.S. Department of Labor
Occupational Safety and Health Administration

Employers must post one of the full size versions (10x16) of this type of OSHA poster or a state-approved poster where required.

checklist

Since the success of a safety and health program depends on identifying hazards and taking immediate remedial action, periodic inspections of the plant are a necessity.

A checklist, such as the one presented on the following pages, can be helpful to management in performing an inspection of the facility. Because businesses vary, it is best that each business develop a customized list from the information in this booklet and a walk-through inspection.

Using this checklist, the manager, supervisor, or employee representative can make periodic inspections (preferably at least once each month) and identify problem areas so that corrective action may be taken.

References made in the "Checklist" subtitles refer to appropriate sections of Occupational Safety and Health Standards, Code of Federal Regulations, Title 29, Part 1910, which are the OSHA General Industry Standards.

WALKING AND WORKING SURFACES

Aisles and Floor (29 CFR 1910.22)

	Yes	No
Are all places of employment kept clean and orderly?	☐	☐
Are floors, aisles, and passageways kept clean and dry and all spills cleaned up immediately?	☐	☐
Are floor holes, such as drains, covered?	☐	☐
Are permanent aisles appropriately marked?	☐	☐
Are wet surface areas covered with non-slip materials?	☐	☐

Storage Lofts, Second Floors, etc. (29 CFR 1910.22, 23)

Are signs showing floor-load capacity present?	☐	☐
Are platforms, storage lofts, balconies, etc., that are more than four feet above the floor protected with standard guardrails?	☐	☐
Are all platforms, lofts, and balconies (from which objects may fall and strike people or machinery below) guarded with standard four-inch toeboards?	☐	☐

Stairs (29 CFR 1910.24)

Are there standard stair rails or handrails on all stairways having four or more risers?	☐	☐
Are all stairways at least 22 inches wide?	☐	☐
Do stairs have at least a seven-foot overhead clearance?	☐	☐
Do stairs angle no more than 50° and no less than 30°?	☐	☐

Ladders (29 CFR 1910.25, .26, .27)

	Yes	No
Have defective ladders (e.g., with broken rungs or side rails) been tagged as "DANGEROUS, DO NOT USE" and removed from service for repair or destruction?	☐	☐
Is it prohibited to use the top of an ordinary step ladder as a step?	☐	☐
Do fixed ladders have at least 3 1/2 feet of extension at the top of the landing?	☐	☐
Is the distance between the centerline of rungs on a fixed ladder and the nearest permanent object in back of the ladder at least seven inches?	☐	☐
Do all fixed ladders have a pitch of 75°-90°?	☐	☐

Exits and Exit Markings (29 CFR 1910.36-.38)

Are all exits marked with an exit sign and illuminated by a reliable light source?	☐	☐
Is the lettering at least six inches high with the principal letter strokes at least 3/4 of an inch wide?	☐	☐
Is the direction to exits, when not immediately apparent, marked with visible signs?	☐	☐
Are doors or other passageways, that are neither exits nor ways to an exit, and located where they may be mistaken for exits, appropriately marked "NOT AN EXIT", "TO BASEMENT", "STOREROOM", etc.?	☐	☐
Are exit doors side-hinged?	☐	☐
Are all doors that must be passed through to reach an exit always free to access with no possibility of a person being locked inside?	☐	☐
Are all exit routes always kept free of obstructions?	☐	☐

OCCUPATIONAL HEALTH AND ENVIRONMENTAL CONTROL

Air Contaminants (29 CFR 1910.1000)

	Yes	No
Are exposed surfaces free of lead, cadmium, zinc, and nickel dusts?	☐	☐
Is employee exposure to chemicals kept within the acceptable levels?	☐	☐
Are eye wash fountains and safety showers provided in areas where chemicals such as caustics are used?	☐	☐
Are all containers, such as vats and storage tanks, labeled as to their contents?	☐	☐
Is vacuuming used wherever possible rather than blowing or sweeping dust?	☐	☐

Occupational Noise Exposure (29 CFR 1910.95)

If a noise problem is suspected, have noise levels been measured?	☐	☐
If a noise problem exists, have plans to reduce noise levels by engineering methods been made (e.g., enclosure, maintenance, different methods of processing)?	☐	☐
If engineering controls cannot reduce the noise to safe levels:		
1. Have administrative controls, such as limiting worker exposure in a given area, been started?	☐	☐
2. Are affected employees given annual audiometric tests, if necessary?	☐	☐
3. Do all employees in high-noise areas wear hearing protection?	☐	☐
4. Are annual noise surveys made to reevaluate the problem?	☐	☐

HAZARDOUS MATERIALS

Flammable and Combustible Liquids (29 CFR 1910.106)

	Yes	No
Are all connections on drums and pipes carrying combustible liquid both vapor and liquid tight?	☐	☐
Are flammable liquids kept in closed containers (parts cleaning tanks, pans, etc.) when not in use?	☐	☐
Are all spills of flammable or combustible liquids cleaned up promptly?	☐	☐
Is combustible waste material (oily rags, etc.) stored in covered metal receptacles and disposed of daily?	☐	☐
Are bulk drums of flammable liquids grounded and bonded to containers during dispensing?	☐	☐
Are gasoline and other flammable liquids stored in approved containers?	☐	☐
Do storage rooms for flammable and combustible liquids have explosion-proof lights?	☐	☐
Do storage rooms for flammable and combustible liquids have mechanical or gravity ventilation (at least six air changes per hour)?	☐	☐
Are storage cabinets for flammable liquids labeled "FLAMMABLE—KEEP FIRE AWAY"?	☐	☐
Is there never more than one day's supply of flammable liquids outside of approved storage cabinets or rooms?	☐	☐

PERSONAL PROTECTIVE EQUIPMENT (29 CFR 1910.132-.137)

Is personal protective equipment provided, used, and maintained wherever it is necessary?	☐	☐

	Yes	No
Is employee-owned personal protective equipment, such as gloves, protective shoes, etc., adequate and properly maintained?	☐	☐
Do employees wear required personal protective equipment (gloves, eye protection, respirators, etc.) when handling hazardous materials?	☐	☐
Is eye protection available where debris or flying objects could be a hazard?	☐	☐
Are ear plugs or muffs provided and worn during noisy conditions?	☐	☐
Is slip-resistant footwear worn?	☐	☐
Are hard hats or safety shoes available where falling objects could be a hazard?	☐	☐

RESPIRATORY PROTECTION DEVICES (29 CFR 1910.134)

Are approved respirators provided when necessary?	☐	☐
Are there written standard operating procedures for the selection and use of respirators?	☐	☐
Is the user instructed and trained in the proper use of respirators?	☐	☐
Where practicable, is a respirator assigned for use by one employee only?	☐	☐
Are respirators cleaned and disinfected after use?	☐	☐
Are respirators stored in a convenient, clean, and sanitary location?	☐	☐
Are routinely-used respirators inspected during cleaning?	☐	☐

GENERAL ENVIRONMENTAL CONTROLS

Sanitation (29 CFR 1910.141)

	Yes	No
Are restrooms and washrooms kept in clean and sanitary condition?	☐	☐
Are covered receptacles for waste food kept in clean and sanitary condition?	☐	☐
Is all water that is provided for drinking, washing, and cooking suitable for drinking?	☐	☐
Are all outlets for water that is not suitable for drinking clearly posted as "UNSAFE FOR DRINKING, WASHING, OR COOKING"?	☐	☐
Are employees prohibited from eating in areas where toxic materials are present?	☐	☐
Has pest control been exercised?	☐	☐
If employees are permitted to eat on the premises, are they provided with a suitable eating space?	☐	☐

Medical and First Aid (29 CFR 1910.151)

Are first aid supplies readily available, inspected, and replenished?	☐	☐
Is at least one employee on each shift qualified to render first aid, if there is no nearby clinic or hospital? (Some states require trained first aiders regardless of nearby clinics or hospitals.)	☐	☐
Are first aid personnel also trained for hazards specific to storage battery manufacture?	☐	☐
Are first aid supplies approved as adequate by a consulting physician?	☐	☐
Are medical personnel readily available for advice and consultation on matters of employee health?	☐	☐

	Yes	No
Is there a first aid kit accessible in the work area?	☐	☐
Are emergency phone numbers posted?	☐	☐
Where employees may be exposed to corrosive materials, are they provided with quick drenching and flushing facilities for immediate emergency use?	☐	☐
Are extinguishers located along normal paths of travel?	☐	☐
Are extinguisher locations not obstructed or blocked?	☐	☐
Are extinguishers not mounted too high? If less than 40 pounds, the top must not be higher than five feet above floor; greater than 40 pounds, the top must not be higher than 3 1/2 feet above floor.	☐	☐
Have all extinguishers been serviced, maintained, and tagged at intervals not to exceed one year?	☐	☐
Are all fire extinguishers checked monthly by a designated employee or an extinguisher service to see if the extinguishers are in place or if they have been discharged, etc.?	☐	☐

Automatic Sprinkler (if applicable)

Is there at least one automatic water supply of adequate pressure, capacity, and reliability?	☐	☐
Are combustible materials kept at least 36 inches from sprinkler heads?	☐	☐
Are water-flow alarms provided on all sprinklers?	☐	☐
Are the sprinkler systems periodically inspected and continuously maintained?	☐	☐

Dry Chemical Systems (if applicable)

Does a competent inspector make annual inspections and perform tests on all dry chemical systems?	☐	☐
Are the inspector's reports kept on file?	☐	☐
Are visual inspections regularly made?	☐	☐

	Yes	No
Are all dry chemical systems maintained in full operating condition at all times?	☐	☐

COMPRESSED AIR (29 CFR 1910.169)

Are pulleys and belts on compressors and motors completely guarded?	☐	☐
Are flexible cords or plugs on electric motors periodically checked and replaced if in a deteriorated condition?	☐	☐
Do the relief valves operate properly?	☐	☐
Are air tanks drained regularly?	☐	☐
Are the pressure-relief device and gauge in good operating condition?	☐	☐

MATERIALS HANDLING AND STORAGE (29 CFR 1910.176-.181)

Is there safe clearance for equipment through aisles and doorways?	☐	☐
Is stored material stable and secure?	☐	☐
Are storage areas free from tripping hazards?	☐	☐
Are only trained operators allowed to operate powered lift trucks?	☐	☐
Are appropriate overhead guards installed on powered lift trucks?	☐	☐
Is battery charging on electric units performed only in designated areas?	☐	☐
Are "NO SMOKING" signs posted near electric battery charging units?	☐	☐
Are all vehicles shut off prior to loading?	☐	☐

	Yes	No
Are dock boards (bridge plates) used when loading or unloading between dock and truck or rail car?	☐	☐
Are containers of combustibles or flammables, when stacked one upon the other, always separated by dunnage sufficient to provide stability?	☐	☐
Are racks and platforms never loaded beyond their capacity?	☐	☐
If motorized equipment, such as lift trucks, is used, are aisles permanently marked, providing sufficient clearance for the equipment?	☐	☐
Are maximum loads posted for floors (except slabs with no basements) and roof of a building, or other structures?	☐	☐

MACHINERY AND MACHINE GUARDING (29 CFR 1910.212)

Are belts, pulleys, and rotating shafts (air compressor, drill presses, etc.) properly guarded?	☐	☐
Are chains, sprockets, and gears properly guarded?	☐	☐
Are all nip points properly guarded?	☐	☐
Are rotating shafts that are not smooth properly guarded?	☐	☐
Are all rotating parts (lubrication, fittings, etc.) recessed or covered with collars?	☐	☐
Are sprockets and V-belt drives which are within reach of platforms and passageways or within seven feet of the floor completely enclosed?	☐	☐
Are fans less than seven feet above floor guarded, with openings 1/2 inch or less?	☐	☐

Abrasive Wheel Machinery (Grinders) (29 CFR 1910.215)

Is the work rest used and kept adjusted to within 1/8 inch of wheel?	☐	☐

	Yes	No
Is the adjustable tongue on top side of grinder used and kept adjusted to within 1/4 inch of wheel?	☐	☐
Do side guards cover the spindle, nut, and flange and 75% of the wheel diameter?	☐	☐
Are bench and pedestal grinders permanently mounted?	☐	☐
Are goggles or face shields always worn when grinding?	☐	☐

HAND AND PORTABLE POWERED TOOLS (29 CFR 1910.242-.244)

Are tools and equipment (both company and employee-owned) in good condition?	☐	☐
Have mushroomed heads on chisels, punches, etc., been reconditioned or replaced if necessary?	☐	☐
Have broken hammer handles been replaced?	☐	☐
Have worn or bent wrenches been replaced?	☐	☐
Have employees been instructed not to use compressed air to blow debris from clothing or body because it can enter the body and cause serious harm?	☐	☐
Have deteriorated air hoses been replaced?	☐	☐
Are portable abrasive wheels appropriately guarded?	☐	☐
Have employees been made aware of the hazards caused by faulty or improperly used hand tools?	☐	☐
Have employees been instructed not to use compressed air for cleaning purposes?	☐	☐

WELDING, CUTTING, AND BRAZING (29 CFR 1910.252)

	Yes	No
Are fuel gas cylinders and oxygen cylinders separated by 20 feet or a barrier five feet high having a 1/2-hour fire resistance rating?	☐	☐
Are cylinders secured and stored where they cannot be knocked over?	☐	☐
Are cylinder protective caps in place except when the cylinder is in use?	☐	☐
Are compressed gas cylinders kept away from sources of heat, elevators, stairs, or gangways?	☐	☐
Are only instructed employees, who are judged competent by the employer, allowed to use oxygen or fuel gas equipment?	☐	☐
Do all cylinders (except those with fixed hand wheels) have non-adjustable wrenches, keys, or handles in place on valve stems while cylinders are in use?	☐	☐
Is welding always conducted at a safe distance from flammable liquids?	☐	☐
Are all compressed gas cylinders legibly marked for identifying the content?	☐	☐
Are the valves shut off when the cylinder is not in use?	☐	☐
Are flash shields provided to protect nearby workers from the welding flash?	☐	☐

NATIONAL ELECTRICAL CODE

Electrical Wiring

Have exposed wires, frayed cords, and deteriorated insulation been repaired or replaced?	☐	☐
Are junction boxes, outlets, switches, and fittings covered?	☐	☐
Is all metal fixed electrical equipment grounded?	☐	☐

	Yes	No
Are flexible cords and cables fastened so that there is no direct pull on joints or terminal screws?	☐	☐
Are flexible cords and cables never substituted for fixed wiring?	☐	☐
Are flexible cords and cables not attached to building surfaces?	☐	☐
Do flexible cords and cables not run through holes in wall or ceiling or through doorways or windows?	☐	☐
Are flexible cords and cables free from splices or taps?	☐	☐
Does all equipment connected by cord and plug have grounded connections?	☐	☐
Are electrical appliances such as vacuums, polishers, vending machines, etc., grounded?	☐	☐
Are all portable, electrical hand tools grounded? (Double-insulated tools are acceptable without grounding)	☐	☐
Are breaker switches identified as to their use?	☐	☐

RECORDKEEPING (29 CFR 1904.2-.8)

Is employee poster (OSHA or equivalent state poster) prominently displayed?	☐	☐
Has a summary of all occupational injuries and illnesses been compiled at the conclusion of each calendar year and been recorded on OSHA Form No. 102? Was it posted during the month of February?	☐	☐
Have all OSHA records been retained for a period of five years, excluding the current year?	☐	☐
Have occupational injuries or illnesses, except minor injuries requiring only first aid, been recorded on OSHA Form Nos. 100 and 101, or equivalent?	☐	☐
Have requirements for recordkeeping been confirmed with state occupational safety and health office, if your state has an approved program?	☐	☐

EXCERPTS
NIOSH/OSHA Draft Technical Standard for LEAD

The following is an excerpt from information contained in the NIOSH SCP guidelines.

These draft technical standards are recommendations to the Department of Labor for its consideration in rulemaking and have no legal status until final rules have been promulgated by that agency. This draft standard is provided for your information only.

"Permissible exposure" means exposure of employees to airborne concentrations of lead and inorganic lead compounds not in excess of 0.2 milligrams per cubic meter (mg/m^3) average over an eight-hour work shift (TWA), as stated in 29 CFR 1910.1000, Table Z-2. (A recommendation has been made to lower the permissible exposure to 0.1 mg/m^3 TWA.)

"Action level" means one-half of the permissible exposure for lead and inorganic lead compounds for an eight-hour work shift.

Exposure determination and measurement Each employer who uses lead or inorganic lead compounds which are released into the workplace air must determine if any employee may be exposed to airborne concentrations of lead and inorganic lead compounds at or above the action level. The determination shall be made each time there is a change in production, process, or control measures which could result in an increase in airborne concentrations of lead and inorganic lead compounds.

Compliance (1) No employee may be exposed to lead and inorganic lead compounds above the permissible exposure limit.

(2) (i) Employee exposures to airborne concentrations of lead and inorganic lead compounds must be controlled by engineering and work practice controls to levels which are at or below the permissible exposure, unless such controls are not technically feasible.

(ii) Wherever engineering and work practice controls are not sufficient to reduce exposures to at or below the permissible levels, they still must be used to reduce exposure to the lowest level feasible and must be supplemented by respirators, as recommended in this section.

(3) Engineering controls (i) When mechanical ventilation is used to control exposure, measurements which demonstrate system effectiveness (e.g., air velocity, static pressure, or air volume) shall be made at least every three months. Measurements of system effectiveness shall also be made within five days of any change in production, process, or control which might result in an increase in airborne concentrations of lead and inorganic lead compounds.

(ii) Open surface tank operations shall be performed in accordance with 29 CFR 1910.94(d).

TABLE 2. RESPIRATORY PROTECTION FOR LEAD AND INORGANIC LEAD COMPOUNDS

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
Dust or Mist Concentration	
1 mg/m^3 or less	Any dust and mist respirator, except single-use.
2 mg/m^3 or less	Any dust and mist respirator, except single-use or quarter mask respirator.
Dust, Mist, or Fume Concentration	
2 mg/m^3 or less	Any fume respirator or high efficiency particulate filter respirator.
	Any supplied-air respirator.
	Any self-contained breathing apparatus.
10 mg/m^3 or less	A high efficiency particulate filter respirator with a full facepiece.
	Any supplied-air respirator with a full facepiece, helmet, or hood.

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
	Any self-contained breathing apparatus with a full facepiece.
200 mg/m^3 or less	A powered air-purifying respirator with a high efficiency particulate filter.
	A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode
400 mg/m^3 or less	A Type C supplied-air respirator with a full facepiece, operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood, operated in continuous-flow mode.
Greater than 400 mg/m^3 or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
	A combination respirator which includes a Type C supplied-air respirator with a full facepiece, operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus, operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece, operated in pressure-demand or other positive pressure mode.
Escape	A high efficiency particulate filter respirator.
	Any escape self-contained breathing apparatus.

(4) Compliance with the permissible exposure may not be achieved by the use of respirators except:

(i) during the time period necessary to install or implement engineering or work practice controls;

(ii) in work situations in which engineering and work practice controls are not technically feasible;

(iii) to supplement engineering and work practice controls when such controls fail to reduce airborne concentrations of lead and inorganic lead compounds to at or below the permissible exposure limit;

(iv) for operations which require entry into tanks or closed vessels;

(v) in emergencies.

(5) Where respirators are needed and permitted under this paragraph to reduce employee exposure, the employer shall select and provide the appropriate respirator from Table 2 and shall ensure that employees use the respirators provided.

(6) Respirators must be approved by the Mining Enforcement and Safety Administration (formally Bureau of Mines) or by the National Institute for Occupational Safety and Health under the provisions of 30 CFR Part 11.

(7) The employer shall institute a respiratory protection program in accordance with 29 CFR 1910.134(b), (d), (e), and (f).

Personal protective equipment (1) Employers must provide and ensure that employees use impervious clothing, gloves, face shields (8-inch minimum) and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with powdered leads or solids or liquids containing inorganic lead compounds. Face shields shall comply with 29 CFR 1910.133(a) (2),(a)(4), (a)(5), and (a)(6).

(2) Employers shall ensure that clothing contaminated with lead or inorganic lead compounds is placed in closed containers for storage until it can be discarded or until the employer provides for the removal of the substance from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the substance, the employer shall inform the person performing the operation of the hazardous properties of the substance.

Medical surveillance (1) The employer must provide medical procedures as required by this paragraph. All medical procedures shall be

performed by or under the supervision of a physician at no cost to the employee.

(2) The employer must make medical examinations available to each employee who is exposed to lead, inorganic lead compounds, liquids containing inorganic lead compounds, or airborne concentrations of lead or inorganic lead compounds at or above the action level. The medical examinations shall include the following:

(i) a medical history and physical examination with emphasis on the gastrointestinal tract, nervous system, kidneys, blood, and gingival tissues;

(ii) blood tests, to include at least red and white cell count, a differential smear, hemoglobin, and determination of lead in the blood;

(iii) urinalysis, to include specific gravity, albumin, glucose, a microscopic examination of centrifuged sediment, and determination of lead in the urine.

(3) Twelve months from the date of the employee's first exposure, the employer shall make medical examinations available to each employee who is exposed to lead or inorganic lead compounds in excess of the action level. The medical examinations must include the following:

(i) a medical history and physical examination with emphasis on the gastrointestinal tract, nervous system, kidneys, blood, and gingival tissues. This examination should be repeated every 12 months;

(ii) blood tests, to include at least red and white cell count, a differential smear, hemoglobin, and determination of lead in the blood. This test should be repeated every 12 months;

(iii) urinalysis, to include specific gravity, albumin, glucose, a microscopic examination of centrifuged sediment, and determination of lead in the urine;

(iv) determination of blood lead level every 6 months (when indicated by results of blood tests and urinalysis);

(v) determination of urine lead level every 3 months (when indicated by results of blood tests and urinalysis).

WORKPLACE HEALTH HAZARD ANALYSIS

Department	Job Description	Exposure Substance(s) (chemical or trade name)	Form(s)	Control	Remarks

FORMS: D = dust; F = fume; G = gas; L = liquid;
M = mist; S = splash; V = vapor

CONTROLS: G = gloves (type)
F = face protection
O = other (type)
LV = local ventilation
GV = general ventilation
R = respirator

JOB HEALTH HAZARD ANALYSIS

Operation: _____ Page: _____

Date: _____

Number of employees	Job title	Exposure substance	Form[1]	Route of entry[2]	Control[3]

1) Form: D = dust, L = liquid, V = vapor, G = gas, F = fume, M = mist
2) Route of entry: S = skin, I = inhalation
3) Control: LV = local ventilation, GV = general ventilation, R = respirator (type), G = gloves (type), F = face protection, O = other protection (type)

INFORMATION SOURCES

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
1430 Broadway, New York, N.Y. 10018

☐ A12.1	Floor and Wall Openings
☐ A14.1	Portable Wood Ladders
☐ A58.1	Minimum Design Load
☐ A64.1	Fixed Stairs
☐ B15.1	Mechanical Power Transmission
☐ C1	National Electrical Code
☐ Z4.1	Sanitation in Places of Employment
☐ Z88.2	Practices for Respiratory Protection
☐ Z89.1-1969	Safety Requirements for Industrial Head Protection

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
470 Atlantic Avenue
Boston, Mass. 02210

☐ NFPA-10-1970	Installation of Portable Fire Extinguishers
☐ NFPA-101-1970	Life Safety Code
☐ NFPA-13A-1971	Sprinkler Systems, Maintenance
☐ NFPA-17-1969	Dry Chemical Extinguishing Systems
☐ NFPA-70-1971	National Electrical Code

NATIONAL SAFETY COUNCIL
425 North Michigan Avenue
Chicago, Illinois 60611

NIOSH and OSHA regional directors, trade associations and insurance companies can also provide useful information. The Small Business Administration will provide information concerning procedures for securing economic assistance on compliance with the OSHA Standards (if needed).

NIOSH AND OSHA REGIONAL OFFICES

The following pages list NIOSH and OSHA regional offices. Either of these facilities serving the state can provide information on the Occupational Safety and Health Act including questions on standards interpretations, voluntary compliance information, copies of the OSHA Standards, OSH Act, Employee Rights Posting Notice, and other OSHA publications.

NIOSH REGIONAL OFFICES

DHEW, Region I
Government Center (JFK Fed. Bldg.)
Boston, Massachusetts 02203
Tel.: 617/223-5807

DHEW, Region II — Federal Building
26 Federal Plaza
New York, New York 10007
Tel.: 212/264-2485/8

DHEW, Region III
3525 Market Street, P.O. Box 13761
Philadelphia, Pennsylvania 19101
Tel.: 215/597-6716

DHEW, Region IV
50 Seventh Street, N.E.
Atlanta, Georgia 30323
Tel.: 404/626-5474

DHEW, Region V
300 South Wacker Drive
Chicago, Illinois 60607
Tel.: 312/353-1710

DHEW, Region VI
1114 Commerce Street (Rm. 8-C-53)
Dallas, Texas 75202
Tel.: 241/792-2261

DHEW, Region VII
601 East 12th Street
Kansas City, Missouri 64106
Tel.: 816/374-5332

DHEW, Region VIII
19th & Stout Streets
9017 Federal Building
Denver, Colorado 80202
Tel.: 303/837-3979

DHEW, Region IX
50 Fulton Street (254 FOB)
San Francisco, California 94012
Tel.: 415/666-3781

DHEW, Region X
1321 Second Avenue (Arcade Bldg.)
Seattle, Washington 98101
Tel.: 206/442-0530

OSHA REGIONAL OFFICES

Region I
U.S. Department of Labor
Occupational Safety and Health Administration
JFK Building, Room 1804
Boston, Massachusetts 02203..... Telephone: 617/223-6712/3

Region II
U.S. Department of Labor
Occupational Safety and Health Administration
1515 Broadway (1 Astor Plaza), Room 3445
New York, New York 10036..... Telephone: 212/971-5941/2

Region III
U.S. Department of Labor
Occupational Safety and Health Administration
15220 Gateway Center, 3535 Market Street
Philadelphia, Pennsylvania 19104..... Telephone: 215/596-1201

Region IV
U.S. Department of Labor
Occupational Safety and Health Administration
1375 Peachtree Street, N.E., Suite 587
Atlanta, Georgia 30309..... Telephone: 404/526-3573/4 or 2281/2

Region V
U.S. Department of Labor
Occupational Safety and Health Administration
230 S. Dearborn, 32nd Floor
Chicago, Illinois 60604..... Telephone: 312/353-4716/7

Region VI
U.S. Department of Labor
Occupational Safety and Health Administration
555 Griffin Square Building, Room 602
Dallas, Texas 75202..... Telephone: 214/749-2477/8/9 or 2567

Region VII
U.S. Department of Labor
Occupational Safety and Health Administration
Federal Building, Room 3000, 911 Walnut Street
Kansas City, Missouri 64106..... Telephone: 816/374-5861

Region VIII
U.S. Department of Labor
Occupational Safety and Health Administration
Federal Building, Room 15010, 1961 Stout Street
Denver, Colorado 80202..... Telephone: 303/837-3883

Region IX
U.S. Department of Labor
Occupational Safety and Health Administration
9470 Federal Building, 450 Golden Gate Avenue
Post Office Box 36017
San Francisco, California 94102..... Telephone: 415/556-0584

Region X
U.S. Department of Labor
Occupational Safety and Health Administration
6048 Federal Office Building, 909 First Avenue
Seattle, Washington 98174..... Telephone: 206/442-5930

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