Occupational Health and Safety

A Manual for Foundry Workers

by Janet Bertinuson and Sidney Weinstein

A LABOR OCCUPATIONAL HEALTH PROGRAM PUBLICATION

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Foundrywork is an extremely hazardous occupation. The types of hazards facing most foundry workers and possible protections are identified in this manual for foundry apprentices. That this information be available to young workers just entering a trade is especially important. However, this manual's usefulness is not limited to apprentices. Older, more experienced workers can also benefit from the information.

ACKNOWLEDGEMENTS

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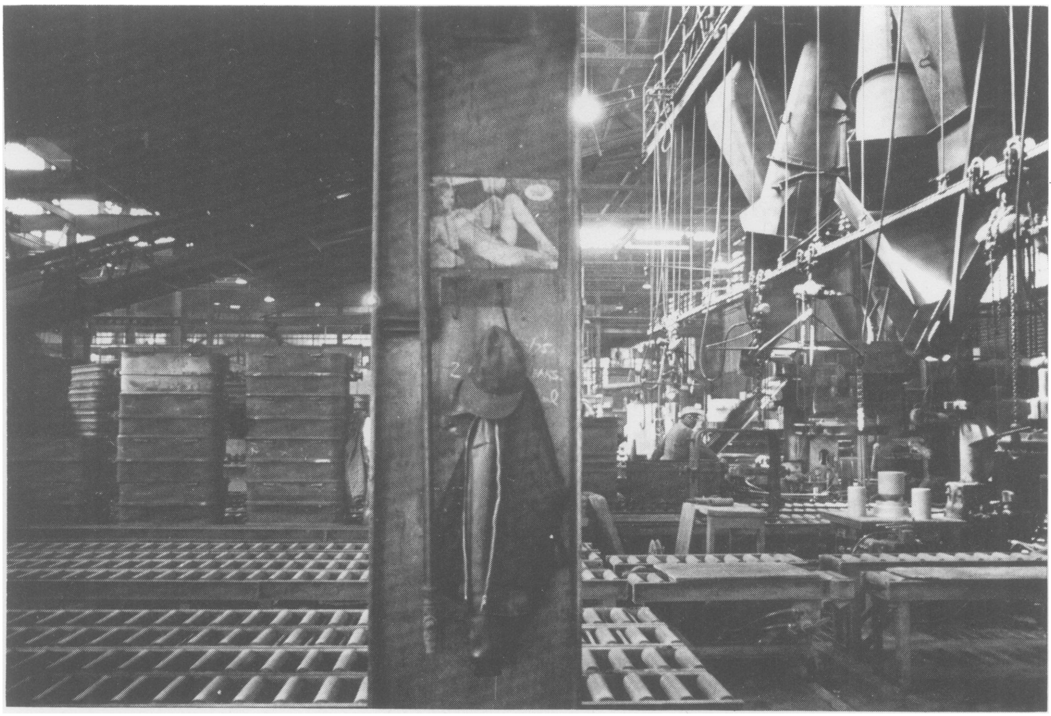


The main foundry floor with conveyors, mold flasks, and overhead sand chutes.

1

INTRODUCTION TO OCCUPATIONAL AND HEALTH SAFETY

Most of the 90 million working men and women in the United States spend one-half of their waking hours at work. Most are exposed at some time to health and safety hazards. Each year thousands are disabled or die from job-related injuries or diseases.

According to a Bureau of Labor Statistics report for 1974, work accidents in the private sector caused 5.6 million injuries, killing 5,200 workers. (these figures *exclude* self-employed individuals and federal, state and municipal employees). Though more difficult to count, occupation-related diseases clearly take a high toll. The same 1974 report estimated that 200,400 private sector workers became ill and 700 died from occupational exposures to dusts, fumes, gases, and other chemical and physical agents. According to the report, "some illnesses of occupational origin may not be recognized and reflected in the statistics." The reasons cited are: occupational diseases often develop slowly, unknown to their victims; workers may change jobs, often making it difficult to monitor their health or associate their disease with a previous exposure.

Every year hazardous substances such as vinyl chloride, asbestos, and Kepone are identified and brought to the public's attention. And every year, thousands of potentially hazardous materials such as plastic resins used in foundry operations are introduced into the workplace environment.

This country has a long history of death on the job. Until recently only dramatic disasters have successfully aroused the public's interest and spurred much-needed protective and compensatory legislation. New York had no worker's compensation until the 1911 Triangle Shirtwaist fire killed 146 women trapped in a clothing factory without fire escapes. The 1930-31 West Virginia Gauley Bridge disaster was even more shocking. By 1935, when the story finally broke, nearly 500 workers had died from tunneling through a mountain with a very high silica content. Though silica usually causes a slow-developing disease, high enough concentrations can cause immediate disability and even death. 169 of the Gauley Bridge victims literally died in their tracks. (Silica is also a widespread foundry hazard). The Gauley Bridge disaster spurred amendment of West Virginia law to compensate workers suffering from silica-related lung disease, though not in time to compensate the Gauley Bridge dead or disabled.

In 1970, Congress finally passed the Occupational Safety and Health Act (OSH Act) to protect nearly all working persons. The OSH Act assures "so far as possible every man and woman in the Nation safe and healthful working conditions." Under this law, the OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) sets and enforces mandatory health and safety standards; the NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH) conducts relevant research and suggests appropriate standards to OSHA. In addition the Act encourages states to administer and enforce their own occupational safety and health programs if they are "at least as effective as the federal programs." As of June 1976, 22 states had programs (see Chapter 9 for more details about the OSH Act).

Many unions, and public interest and scientific groups have been very active in the field of occupational health and safety. Three especially active international unions—UNITED AUTO WORKERS (UAW), OIL, CHEMICAL AND ATOMIC WORKERS (OCAW), and UNITED RUBBER WORKERS (URW)—have called strikes over health and safety conditions, negotiated health and safety contract language, testified at OSHA standards hearings, promoted research on hazardous substances, set up occupational safety and health offices, or established educational programs for their members. Scientific groups such as MT. SINAI ENVIRONMENTAL SCIENCES LABORATORY have identified hazards associated with asbestos, plastics, roofing materials, printing materials, and others. Public interest groups such as the ENVIRONMENTAL DEFENSE FUND and the HEALTH RESEARCH GROUP have testified at OSHA standards hearings and filed written comments on standards proposals. THE CHICAGO AREA COMMITTEE FOR OCCUPATIONAL SAFETY AND HEALTH (CACOSH) has promoted stricter enforcement of OSHA's noise standard and passage of a stricter noise standard. Other COSH groups are active throughout the country.

THE AMERICAN FOUNDRYMEN'S SOCIETY, based in Des Plaines, Illinois, prepares educational materials and conducts studies on many aspects of foundry work, including occupational health and safety hazards.

2

INTRODUCTION TO FOUNDRY HAZARDS

Foundry work is one of the most hazardous industries. Nearly a quarter of a million Americans work in the nation's iron and steel foundries. Every day approximately 270 will be injured on the job. That's nearly *70,000 each year*, or *1 in 3* workers. Of these, more than 65 will die each year from their work-sustained injuries.

The average incidence of disabling injuries ranges between 23.2 and 35.5 per million hours worked, well above the national average for all industries. When broken down by operation, some foundry injury rates are 4 times the national average of 11.

WORK PROCESS	DISABLING INJURIES AND DISEASES/ MILLION HOURS WORKED
Materials Handling	16.4
Molding	32.5
Melting and Pouring	43.8
Shakeout and Core Knockout	47.7

Molding, with 2,070 days lost per million hours worked, has the highest severity rate of all foundry operations. Cleaning, chipping, and finishing operations together cause 19 percent of the total lost days and 29 percent of the total injuries. (These figures are from OSHA's NEP).

Because of the high injury and illness rates and the great number of lost workdays, iron and steel foundries have been selected as part of OSHA's National Emphasis Program (NEP) along with aluminum, bronze, brass, copper, and copper alloy casting. The NEP program specifically emphasizes special compliance inspections and employer-employee training to reduce injury and illness rates.

Foundry work consists of several specialized, interlocking jobs such as molding and coremaking, melting, pouring, shakeout, core knockout, and cleaning, chipping, and finishing. All require heavy labor, and all can be hazardous. Foundry noise levels are nearly always high enough to permanently damage the hearing of consistently exposed workers. The excessive heat can cause headaches, confusion, fainting, convulsions, even coma. Overexposure to the always present dusts, vapors, and fumes can cause chronic, disabling lung diseases such as silicosis and emphysema. Third-degree burns, crushed limbs, and amputations are common. Accidents can occur because of unguarded machinery, poor housekeeping, or improper materials handling or equipment operation. The combination of heat, noise, vapors, dust, fumes, and heavy labor fatigues workers quickly. A tired worker is apt to be careless, less aware of hazards, and therefore prone to overexertion. Strains and overexertion accounted for 20 percent of the foundry injuries reported by a 1974 State of Wisconsin study.

In molding and coremaking, burns, eye injuries, back injuries, and limb-crushing accidents are common. The silica in molding sand and mold-release agents can cause silicosis, a chronic lung disease. Talc mold-release agents can cause ''white lung'' (talcosis), a lung ailment similar to silicosis and common among talc workers. Talc, chemically similar to asbestos, may also contain asbestos fibers. Asbestos is a well-known carcinogen (cancer-causing substance).

The resins and solvents used to make cores and molds—phenolic resin, urea (isocyanate-based) resin, urea-formaldehyde resin, and furan resin—are potential skin irritants. Mold and core baking and drying can produce hazardous decomposition products such as ammonia. Isocyanates, formaldehyde, and ammonia generally irritate the eyes and respiratory tract. Isocyanates such as toluene-2, 4-diisocyanate (TDI) and methylene diphenyl diisocyanate (MDI), used to bind some no-bake cores, may cause asthma-like symptoms at even low exposure levels. While ''curing,'' no-bake cores can produce hazarous levels of MDI.

Fumes and vapors from chemicals used to prepare molds and from molten metal are frequently poisonous. Molds may be sprayed with nickel carbonyl, a reported carcinogen. Hot metal hitting a mold bonded with formaldehyde resins can ignite the formaldehyde vapors. The resulting fumes may combine spontaneously with hydrochloric acid in the foundry atmosphere to produce the lung carcinogen, bis-chloromethyl ether. At one chemical plant, workers exposed to this substance developed lung cancer at 8 times the rate for the average population.

During pouring, furnaces and molten metal produce dangerous levels of carbon monoxide and fumes that spread throughout the foundry. Ultraviolet and infrared radiation from white-hot metal can severely damage unprotected eyes and skin. Molten metal explosions from contact with water or cold surfaces are always potential causes of severe burns. An entire furnace can explode due to water vapor trapped in melting pieces of closed scrap pipe. Moisture remaining in sand can explode a mold, throwing molten metal at nearby workers. In addition, without proper venting, a mold may blow up due to expanding gases. Lace boot burns are particularly common in pouring operations. Once molten metal has penetrated through the shoe or boot lacings, serious burns are virtually impossible to prevent. A federal standard requires workers to wear safety shoes ''where necessary.'' Gaiter-type shoes and boots are readily available.

Shakeout exposes workers to many of the same hazards involved in molding, coremaking, and pouring—heat, extreme noise, gases, dusts, vapors. Shakeout is one of the noisiest foundry operations. It can release dangerous resin vapors and toxic decomposition products. Crushed or broken hands or feet are common. Workers can be injured by losing their balance while pulling castings or while trying to retrieve gagger irons from still-operating machines. Flasks can fall off shakeout machine plungers, and sand and other materials can fall off unguarded conveyor belts. Sand and other debris cluttering the shakeout area are also potential causes of accidents.

Workers in the knockout shop have the highest injury and disease rate in the foundry. Improperly guarded grinding wheels spinning at excessive speeds frequently explode. Eye injuries and amputations are more common here than in any other part of the foundry. Silica adhering to castings after shakeout and from finishing abrasives, and metal dusts from grinding and finishing are also hazards. Noise is excessive in the knockout shop.

Without worker, employer, and government action, the foundry work environment will remain exceptionally hazardous. While worker exposures to well-known hazards such as carbon monoxide and silica continue unchecked, new chemicals and processes are being constantly introduced. Few have been tested for their effects, especially long-term, on the human body. Very little, for example, is known about the plastic resins used in mold or core making, or about their decomposition products.

What is known—*many foundry workers are being exposed to these substances and foundry workers die younger than other workers.* Furnacemen, grinders, and chippers together have almost twice the death rate of non-foundry workers of comparative age groups. For furnacemen alone, this increase is almost 83 percent.

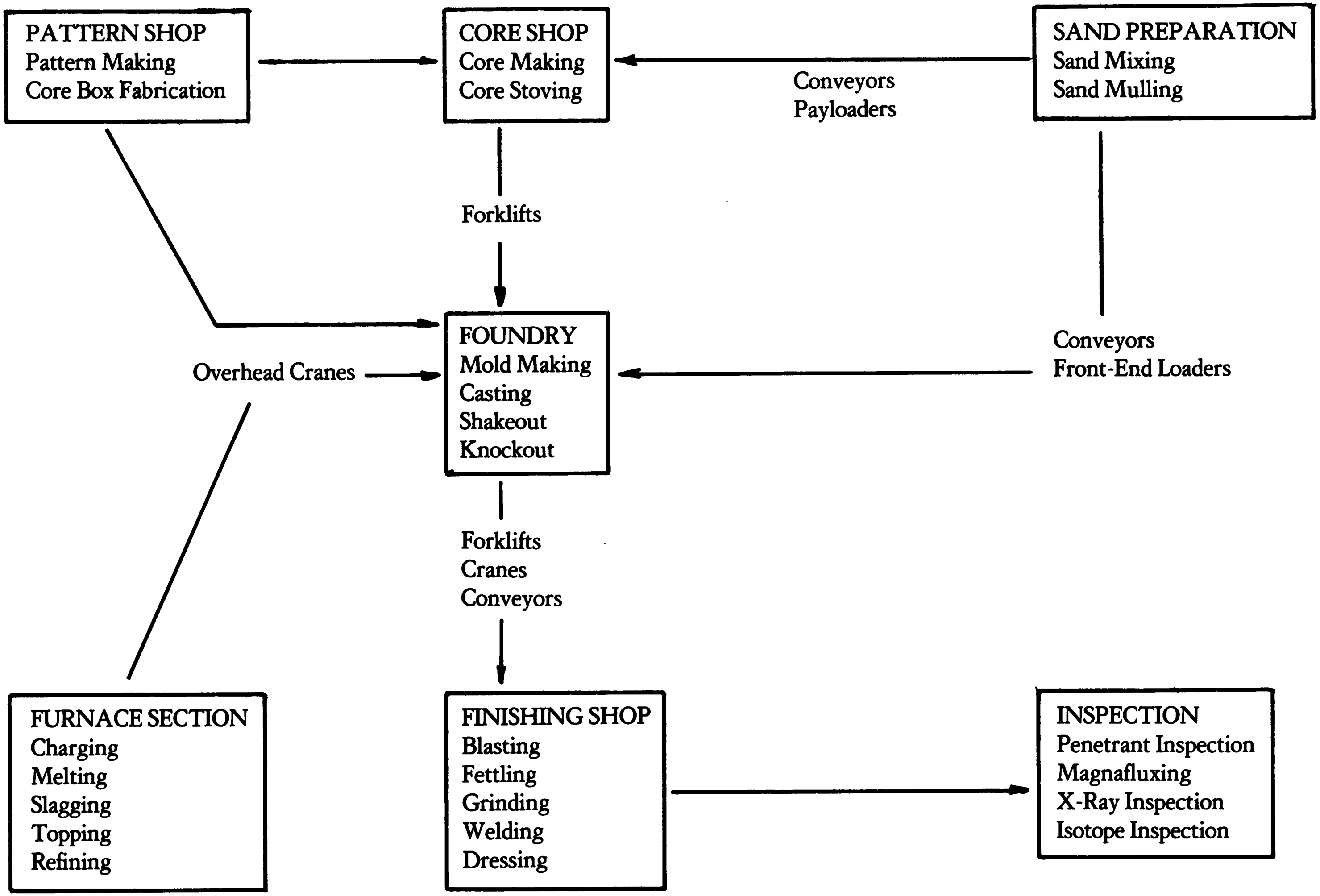


Table 2-1 FLOW CHART OF FOUNDRY PROCESSES

PATTERN SHOP
- Saw Dust
- Noise
- Electrical Hazards
- Manual Lifting
- Moving Machine Parts

CORE SHOP
- Silica Dust
- Noise
- Explosion
- Heat
- Moving Machine Parts
- Metal Fumes
- Toxic Vapors

SAND PREPARATION
- Noise
- Silica Dust
- Moving Machine Parts

FOUNDRY

Silica Dust	Lifting
Talc	Toxic Vapors
Heat	Metal Fumes
Noise	Moving Machine Parts
Fire	Falling and Flying Objects
Explosion	Nonionizing Radiation
Poor Housekeeping	

FURNACE SECTION
- Noise
- Heat
- Nonionizing Radiation
- Explosion
- Fire
- Molten Metal
- Gases
- Metal Fumes

FINISHING SHOP
- Silica Dust
- Noise
- Flying and Falling Objects
- Lifting
- Metal Fumes
- Gases
- Nonionizing Radiation
- Electrical Hazards

INSPECTION
- Nonionizing Radiation
- Ionizing Radiation

Table 2-2 **HAZARDS ASSOCIATED WITH FOUNDRY PROCESSES**

3

CHEMICAL HAZARDS

A chemical's physical state—gas, vapor, fume, liquid, solid—and its particular properties determine how it enters and affects the body. Most hazardous substances in foundries are either breathed in or cause damage when they come in direct contact with the skin. Hazardous materials can also be absorbed through the skin or be swallowed. The respiratory system (nose, air tubes, lungs) and the skin have well-developed defense systems (described throughout this chapter) protecting the body against invasion. However, these defense systems can be worn down or overcome. Even where defenses exist, they will not protect the body against all hazards.

Adverse health effects may be:

ACUTE: developing quickly, usually after exposure to high concentrations of a hazardous material, or

CHRONIC: taking a long time to develop or requiring lengthy exposures, usually at low concentrations

Acute effects are readily seen. For example, contact with the solvent phenol can immediately cause severe skin irritation. Chronic effects usually do not show up for years, often making it difficult to link an exposure with the disease or effect.

For example, silicosis—a disabling lung disease—is usually chronic and shows up a number of years after initial exposure. Health effects are also classified by *where* hazardous substances affect the body:

LOCAL: developing where the substance enters the body or comes into direct contact, or

SYSTEMIC: developing at some place other than the point of contact

Cadmium, a copper contaminant, can irritate the lungs (point of contact) causing the lungs to fill with fluid (local effect) or damage the liver and kidneys (systemic effect).

Foundry workers are potentially exposed to many toxic dusts, metal fumes, gases, and vapors.

A. DUSTS

Dusts are solid particles suspended in air, produced by crushing, grinding, sanding, or impact. The body's defenses against dusts are shown in the figure below. Only the finest dust particles reach the lungs. Usually the most damaging dusts (''respirable'') can't be seen with the naked eye.

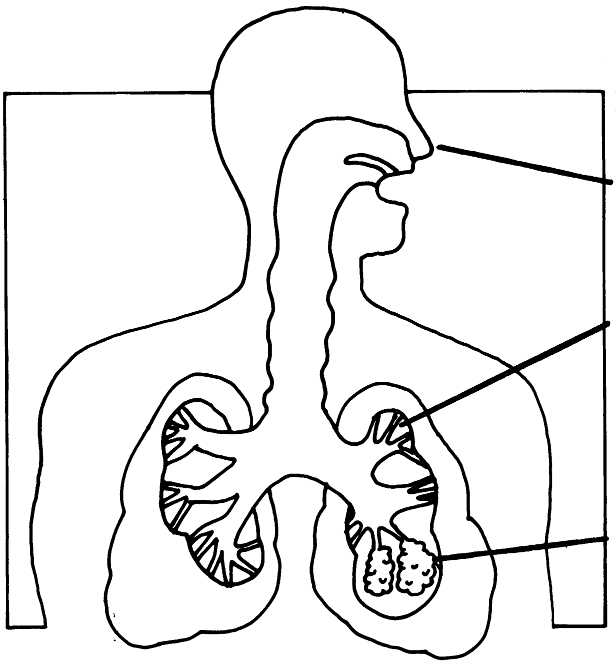


Fig. 3-1: Lung Diagram

NOSE: Large particles are trapped in mucus and hair. They are blown out when you blow your nose.

AIR TUBES: Particles impact on walls of air tubes and are caught in mucus. Tiny hair-like fibers (cilia) beat and move the particles up the airways—muco-ciliary escalator. They are then coughed out or swallowed.

AIR SACS (ALVEOLI): Tiny dust particles are surrounded by special white blood cells and move up the muco-ciliary escalator.

In foundries, silica is the primary dust hazard though foundry workers may also be exposed to asbestos and talc dust. (Table 3-1 at the end of Chapter lists the dusts to which foundry workers are exposed, the processes generating these dusts, and resulting health effects).

1. SILICA

In foundries silica dust is the most widespread hazard and the air contaminant most likely to exceed legal standards. The main foundry sources of free silica (quartz) are mold and core sand, powdered mold release agents, binder clays (usually bentonite), and natural abrasive grinding wheels. Silica dust can be a problem wherever ventilation is inadequate or nonexistent or housekeeping is poor. The dust can be spread throughout the foundry by air currents and vibrations from equipment used to transport or handle the sand, such as mullers, blenders, hoppers, conveyor belts, and elevators.

Foundry workers may be exposed to high silica dust concentrations from mulling, mixing, shakeout, grinding, or blasting operations, or from handling sand or dusty castings.

Inhaling large amounts of free silica over a number of years can result in a chronic disabling lung disease, *silicosis.* Silicosis develops as scars form around silica particles embedded in the lung walls, reducing lung function and breathing capacity. Symptoms—shortness of breath, reduced ability to work, dry cough, loss of appetite, increasing tiredness—generally appear years after the first exposure. Silicosis eventually results in weight loss, extreme tiredness, and an inability to work. Other lung infections, especially tuberculosis, and heart disease are common silicosis-related causes of death.

Silicosis may be spotted by lung function tests and X-rays (see chapter 10, Medical Screening) before workers realize they have the disease. Employers should regularly provide such tests for every potentially exposed worker. However, even if silicosis is diagnosed and the affected worker removed from the exposure, the disease can still get worse. *The only treatment is PREVENTION.*

CURRENT STANDARD

Presently there's no agreement on the amount of free silica a worker may "safely" inhale. A federal standard does exist, though using it is confusing. The standard (threshold limit value or maximum allowable concentration) is determined by the amount of free silica in a sample, and can therefore vary between samples taken at the same workplace as well as between different workplaces. Controlling foundry workers exposure is very difficult since the amount of silica constantly changes, depending upon how much molding is being done, what kinds, how good the housekeeping is, how much sand is being transported back and forth, etc. To determine precise worker exposures and whether the standard is being exceeded, employers should take accurate, continuing measurements.

Use the following formula to compute the appropriate silica concentration in mg/M^3 (milligrams of silica per cubic meter of air):

$$\frac{10}{\text{percent free silica in the sample} + 2}$$

For a sample with *8 percent* free silica, we find the maximum allowable silica concentration is:

$$\frac{10}{8+2} = \frac{10}{10} = 1.0\ mg/M^3$$

For a sample with *48 percent* free silica, the maximum allowable silica concentration is:

$$\frac{10}{48+2} = \frac{10}{50} = 0.5\ mg/M^3$$

Thus, *the more free silica in the air, the lower the allowable concentration.*

HOW DO YOU KNOW IF A SILICA PROBLEM EXISTS?

Though you can generally assume silica is a hazard if the foundry looks dirty or if you can see dust, a problem can exist without large amounts of visible dust. Remember—only invisible particles reach the lungs to cause silicosis. Chapter 6, Hazard Identification, contains some clues for identifying a silica hazard. Basically look out for:

Sand dropping from a conveyor or bin into an open area

Dust escaping from shot blast cabinets, either at the top or ground level

Lack of ventilation around any area where sand may be released, such as mulling and casting cleaning (see ventilation section of this chapter for other operations)

If a silica problem is suspected, the employer should take air samples to determine the hazard's actual severity. Silica samples are taken with a pump (usually clipped to a worker's belt) attached to a pre-filter and to a filter which traps the "respirable" dust particles. The dust trapped on the filter is analyzed for its free silica content, and the maximum allowable concentration is figured out using the formula:

$$\frac{10}{(\text{percent of free silica in the sample} + 2)}$$

Silica exposures are best controlled at the source by ventilation systems, by modifying dust-producing processes and machinery, and by substituting permanent metal, wood, or fiberglass molds (not always possible) for temporary sand molds (see control section of this chapter). Respirators are useful for emergency situations, but should never be a permanent protective measure. They are uncomfortable, make breathing difficult, and are often heavy.

2. OTHER DUSTS

Other hazardous dusts such as asbestos and talc may also be present. Asbestos, used in riser sleeves may be generated while cutting sleeves to fit or during shakeout. Talc, used as a mold release, might be released during molding and shakeout.

Both asbestos and talc can cause disabling lung diseases (asbestosis and talcosis) similar to silicosis. Asbestos exposure can cause a rare form of cancer, mesothelioma, which affects the lining of the chest and stomach. It is also associated with increased lung, large intestine, and rectal cancers. Workers should beware of exposing their families through dust on their workclothes.

The standard for asbestos exposure is:

2 fibers/cc (cubic centimeter)

The fibers must be greater than 5 microns in length (a micron = 1/25,000 inch). In addition to the fiber limit, the asbestos standard provides for monitoring, medical examinations, and standard work practices such as vacuum cleanup or wet sweeping and disposal of all asbestos waste in sealed containers.

There are actually three possible standards for talc exposure. If the sample is:

MORE THAN 1 PERCENT FREE SILICA: use silica standard

LESS THAN 1 PERCENT FREE SILICA: use 20 mppcf (million particles per cubic foot)

FIBROUS: use asbestos standard (talc is often contaminated with asbestos)

As with silica, a pump and filter assembly is used to take asbestos and talc samples. Controlling worker exposures to asbestos and talc is best achieved by source controls—ventilation, process and machinery changes, or substituting a less hazardous material. However, beware of substituting other untested materials.

B. FUMES

Fumes are solid particles suspended in the air, usually formed by cooling vaporized metals. These fine particles (smaller than dusts) are primarily an inhalation hazard. Fumes can directly affect the lungs. For example, cadmium, used in silver solder and a copper contaminant, can cause the lungs to fill with fluid (pulmonary edema). Many metal fumes can also irritate the skin and eyes. A number of metal fumes such as zinc oxide, magnesium oxide, and copper oxide can cause *metal fume fever,* thought to be an allergic reaction. Only newly exposed workers or those who've been away from exposure for a significant amount of time develop symptoms. The condition's flu-like symptoms—chills, fever, general weakness, and sometimes nausea and vomiting—disappear within 24 to 72 hours, apparently without long-term effects.

Because of their small particle size (usually less than 1 micron) and ability to dissolve in other substances, fumes can easily pass from the lungs into the blood stream to damage other parts of the body. Resulting chronic problems can be lung diseases such as berylliosis and cancer, liver and kidney damage, and nervous system disorders such as tremor, memory loss, psychological disturbances, etc. (see Table 3-2 at end of Chapter).

Foundries produce a number of metal fumes, particularly around melting, pouring, and welding operations. In iron (ferrous) foundries, iron oxide may be produced by electric or cupola furnaces, or on the pouring floors. In noniron (nonferrous) foundries, other metal fumes such as aluminum, lead, magnesium, and nickel are more likely to be a problem. The trace components of metal alloys and solders can also be hazardous (Table 3-2 at end of Chapter lists many fumes to which foundry workers are exposed, and their resulting health effects).

Lead is one of the most hazardous fumes produced in nonferrous foundries. Chronic exposures can cause anemia, stomach cramps and pain, nervous system disorders, and effects on *both* male and female reproductive systems.

C. GASES

Formless at room temperature, gases expand to fill their containers—whether cylinder, bag, room, etc. They can be changed into liquids or solids only by increasing pressure *and* decreasing temperature.

Toxic gases can directly irritate the skin, throat, lungs, or they may pass from the lungs into the blood stream to damage other parts of the body. Some gases can also cause suffocation (asphyxiation) by replacing oxygen in the air.

The body's defenses against some gases include smell, tearing eyes, and coughing. For example, ammonia's irritating effects and characteristic odor warn workers of exposure. However, workers may be exposed to some gases without their knowledge. Carbon monoxide has no warning properties. Other gases may dull the sense of smell after awhile. In foundries, the primary gas hazard is carbon monoxide from melting, pouring, and shakeout. High concentrations of ozone, nitrogen dioxide, and carbon dioxide may also be produced by melting, pouring, and welding operations. (Table 3-3 at end of Chapter lists many gases to which foundry workers are exposed, and their resulting health effects).

CARBON MONOXIDE

Carbon monoxide is a colorless, odorless gas formed by burning carbon-containing material such as coal, coke, oil, or gasoline. The chief source of carbon monoxide in the general environment is the automobile. In foundries, high carbon monoxide concentrations may be produced by:

- CUPOLA MELTING FURNACES which are charged with coke, pig iron or iron and steel, scrap, and limestone
- COMBUSTIBLE MATERIALS BINDING MOLD AND CORE SAND, released during pouring and shakeout
- COKE OR COAL-FIRED SALAMANDERS used as space heaters
- EXHAUST FUMES FROM EQUIPMENT such as forklifts, pay loaders, and front-end loaders loaders, and front-end loaders

After being breathed in, carbon monoxide can combine with the blood's oxygen carrier, hemoglobin. Because hemoglobin combines much more readily with carbon monoxide than oxygen, exposure to significant carbon monoxide levels can reduce the entire body's oxygen supply. Initial symptoms can include headache, dizziness, nausea, and vomiting. Higher exposures can result in a worker's passing out or death. This ''oxygen starvation'' most severely affects the heart and brain. Persons with existing heart conditions, if exposed to significant levels of carbon monoxide, are more susceptible to additional heart damage.

Because carbon monoxide has no warning properties, the only way to know whether workers are being exposed is to regularly monitor the foundry air (an employer responsibility). Carbon monoxide concentrations can be measured by direct reading instruments, either detector tubes or carbon monoxide meters (see Monitoring at the end of Chapter). Alarm-equipped carbon monoxide meters also help warn workers that gas levels are excessive. These systems must be set low enough to insure that workers are being adequately protected.

To protect exposed workers, control carbon monoxide emissions at their source. Local exhaust ventilation is most effective as long as the ventilating suction is located well behind the cupola stack, or over the pouring and shakeout areas. When carbon monoxide is more than 2 percent of the air, workers should use employer-provided air-supplied respirators, oxygen-supplied gas masks, or hose masks with blowers. However, only use respirators as emergency or temporary measures.

Employers should also regularly monitor workers' carbon monoxide blood levels, and inform all potentially exposed workers of possible health effects.

The current OSHA standard for carbon monoxide exposure is 50 ppm. NIOSH has recommended revising the standard to 35 ppm to more adequately protect most workers.

D. VAPORS

Vapors are gaseous forms of substances that are normally solids at room temperature. They usually form when solids or liquids are heated. However, substances such as mercury metal and most solvents can vaporize without being heated. Primarily an inhalation hazard, vapors may directly irritate the throat, air tubes, or lungs, or pass into the bloodstream to damage other parts of the body. Many vapors and the substances from which they are evaporated may also irritate the skin and eyes. As with gases, vapors' irritating effects or smell may warn workers of exposure.

In the foundry vapor sources include cleaning solvents, substances such as vegetable and linseed oils used to bind mold and core sand, resins, and catalysts. The use of new and often complex resins to bind mold and core sand has increased the numbers and types of vapors to which foundry workers may be exposed. Unfortunately, little is known about the vapors and decomposition products of many resins. (Table 3-4 at end of Chapter lists many vapors to which foundry workers are exposed, and their resulting health effects).

MOLDING AND COREMAKING

Molding and coremaking processes were briefly described in Chapter 2. Resins, increasingly used to bind mold and core sand, may produce a wide variety of toxic vapors during molding and coremaking, pouring, and shakeout operations.

To make most molds, silica sand, held together either by moisture or a binding agent, is rammed around a pattern by molding machines or sand slingers, or by hand. The molds are then baked or "cured." Cores are made of bonded silica sand packed into core boxes made of wood, metal, or other durable materials by core blowing machines, or by hand. As with the molds, the cores are then either baked or "cured." When fitted inside molds, these preformed shapes create holes or recesses in the final casting. Most cores and molds also contain inert substances such as starch, corn cobs, or coal.

The different molding and coremaking processes are:

GREEN-SAND MOLDS: silica sand and special additives bonded with clay and water (not baked)

DRY-SAND MOLDS: silica sand bonded with oils (baked)

LOAM MOLDS: silica sand bonded with clay and water slurry (baked)

SHELL MOLDS: fine silica sand bonded with urea-formaldehyde or phenol-formaldehyde resins (baked)

CARBON DIOXIDE MOLDS: silica sand and sodium silicate with carbon dioxide blown through (not baked)

CATALYZED CHEMICAL MOLDS: silica sand bonded with cold-cure—(alkyd-isocyanates, phenolic-urethane, or phenolic-formaldehyde resins—or hot-box resins mixed with a catalyst (not baked)

1. HAZARDS OF BAKED CORES AND MOLDS

In DRY-SAND molding and coremaking, silica sand is bonded with special oils and baked. This process is used particularly for steel and other alloy castings. When heated, the oils can release hazardous decomposition products such as highly irritating acrolein vapors. (see Table 3-4 at end of Chapter).

In the SHELL MOLD process, fine silica sand is mixed with phenol-formaldehyde or urea-formaldehyde resins. A shell is formed by dropping the sand mixture onto hot (400-500°F) metal pattern plates, then baking the mold in a 600°F oven. Prior to baking, hazardous vapors can be released by hexamethylene tetramine (HEX), a highly irritating and explosive reactant used with phenol-formaldehyde resins. Baking, pouring, and shakeout operations release toxic vapors and decomposition products from the resins. Carbon monoxide, formaldehyde, and ammonia are common (see section on gases). Formaldehyde and phenol vapors can both strongly irritate the eyes, mouth, air tubes, lungs, and skin. Formaldehyde is also a skin sensitizer (produces an allergic reaction); phenol can damage the liver, kidneys, and nervous system if exposure is chronic.

2. HAZARDS OF NO-BAKE CORES AND MOLDS

In no-bake molding and coremaking, a chemical reaction between a catalyst and the resin bonding agent sets the mold or core without baking. Catalysts are usually acids such as sulfonic or phosphoric. The resin binders are usually mixtures of urea, formaldehyde, furfuryl alcohol, phenol, and isocyanates.

In the COLD-CURE process, an acid catalyst provides enough heat for the sand-resin mixture to harden or "cure" at room temperature. The resins used are often alkyd-isocyanates or phenolic-urethane; a new process being developed uses phenol-formaldehyde. The setting time depends upon the amount of catalyst used and how hot the sand mixture becomes, and "curing" begins as soon as the binder and catalyst come into contact. In the HOT-BOX process, sand is bonded with similar resins (*not* aklyd-isocyanates or phenolic-urethane). However, the catalyst is weaker because the sand is blown into preheated (400-500°F) core boxes.

Both cold-cure and hot-box processes can release toxic resin vapors during curing, pouring, and shakeout operations. The hazards associated with these vapors include:

PHENOL-FORMALDEHYDE AND UREA-FORMALDEHYDE RESINS: can strongly irritate eyes, mouth, air tubes, lungs, and skin. Formaldehyde is also a skin sensitizer; phenol can damage liver, kidneys, and nervous system with chronic exposure

PHENOLIC-FORMALDEHYDE RESINS (used in new, experimental cold-cure process): releases triethyl amine, a strong irritant to the skin, mucous membranes, and lungs

ALKYD-ISOCYANATES AND PHENOLIC-URETHANE RESINS: release hazardous amounts of toluene diisocyanate (TDI) and methylene diphenyl isocyanate (MDI); both are potent eye and air tube irritants. Exposed workers can become sensitized (develop allergic reaction)

SULFONIC ACID: actually a mist (liquid particles suspended in air), can burn or strongly irritate the skin, eyes, throat, and lungs

PHOSPHORIC ACID: also a mist, can also burn and strongly irritate the eyes, skin, throat, and lungs

Both TDI and MDI are extremely dangerous. About half the workers consistently exposed to these substances become sensitized. When this happens, even minute exposures can cause dry hacking cough, chest pain, spasms of the large air tubes (bronchi), wheezing, and difficulty breathing. Engineering controls are essential to controlling isocyanate vapors. For sensitized persons, *no* exposure is safe.

3. WORKER PROTECTIONS

When workers are exposed to hazardous vapors from these processes, the surrounding air should be monitored for specific vapors or possible decomposition products. If monitoring shows workers are being exposed to hazardous levels, control measures must be established. The best are source controls—ventilation systems, process modification, or substitution of less hazardous substances. Respirators should be used only in emergencies or while engineering controls are being implemented. They are *not* effective permanent solutions because the vapors remain in the total foundry environment. When used, respirators must protect wearers against the specific vapors to which they are exposed.

E. MONITORING FOR CHEMICAL HAZARDS

Knowing workers' exact exposures to chemical hazards is important to both employees and employers: employees because they may be exposed to potentially dangerous substances or to physical hazards; employers because they are responsible for controlling workers' exposures to hazardous substances or situations. As a first step in controlling worker exposures, employers must make provision to monitor (measure) air contaminants in the work environment. A variety of monitoring instruments are available. Many are expensive and elaborate. Generally, these instruments should be used by trained persons such as industrial hygienists, although workers can be trained to use the instruments. No matter who does the monitoring, workers have the right to see the results.

SAMPLING PRINCIPLES

The three basic sampling principles are: where should sampling be done (what type of samples); how many samples should be taken; how long should sampling continue:

WHERE: Sample at the point of exposure. Worker's exposures can best be determined by sampling the air they actually breathe—a breathing zone sample. A sampler can be worn all day, taking in air as close to the breathing zone as possible.

HOW MANY: Take enough samples to give a good indication of actual worker exposures (experience or established sampling principles may determine this), to account for peak exposures, and to account for any changes in air levels due to seasonal or operational variation.

HOW LONG: Sample as close to 8 hours as possible. Most standards are 8-hour averages. If a continuous 8-hour sample is impossible, several shorter samples can be taken and averaged. Where standards are "ceiling" levels (values that can *never* be exceeded), short-term "peak" samples should also be taken.

Air sampling instruments or sampling set-ups can be direct-reading or require lab analysis. One of the simplest and least expensive direct-reading instruments available is the detector tube and pump illustrated.

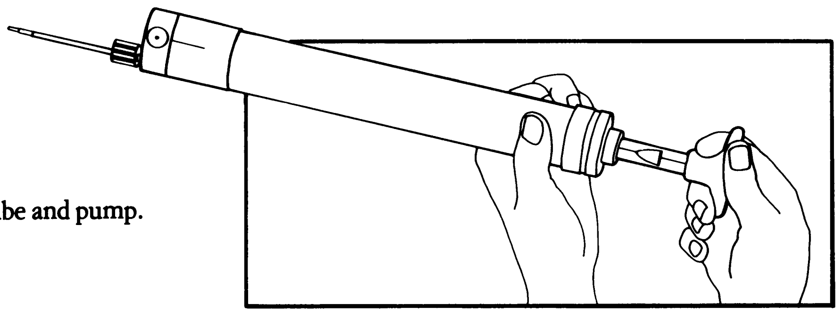


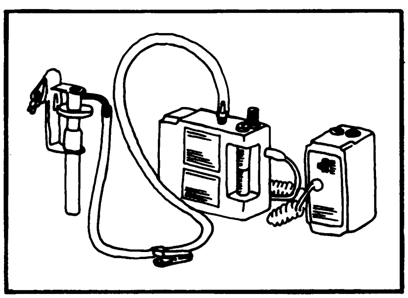
Fig. 3-2: Detector tube and pump.

Air is drawn through a tube containing a chemical that changes color in proportion to a particular substance's concentration. These tubes are available for more than 100 gases and vapors. Many are now certified by NIOSH.

Other direct-reading instruments pull air directly through a sampling opening and read out the contaminant's concentration on a meter. Examples are carbon monoxide indicators and explosive gas meters.

More elaborate sampling systems consist of a manual or electric-powered pump and a sample collector. The collector may be a dust or fume filter or a special bottle (called an impinger) cylinder, or bag for vapors and gases. These samples require lab analysis to determine exposure levels.

Fig. 3-3: Pump and filter assembly.



F. CONTROLLING AIRBORNE CHEMICAL HAZARDS

Once sampling determines that workers are being exposed to "dangerous levels of hazardous materials," their exposures must be reduced and controlled. The most effective method is to control the hazard at its source, particularly by local exhaust ventilation. Source controls prevent substances from reaching workers' respiratory systems. Other source controls include modifying a work process or substituting less hazardous substances.

Local exhaust systems, to be effective, must:

1. *Be designed for the specific operation*—paint spray-booth exhaust systems have different designs than shell core molding systems (see figures for exhaust system examples).

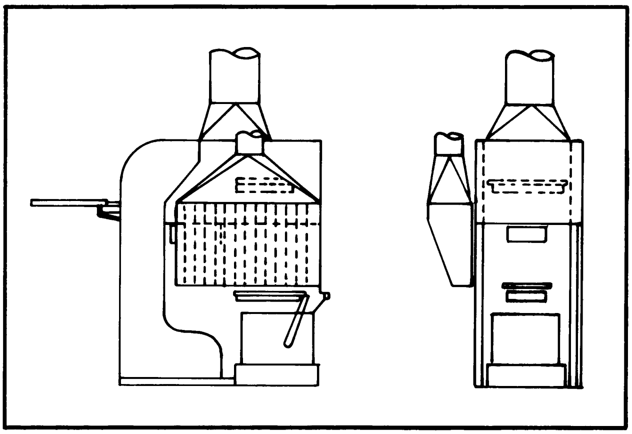
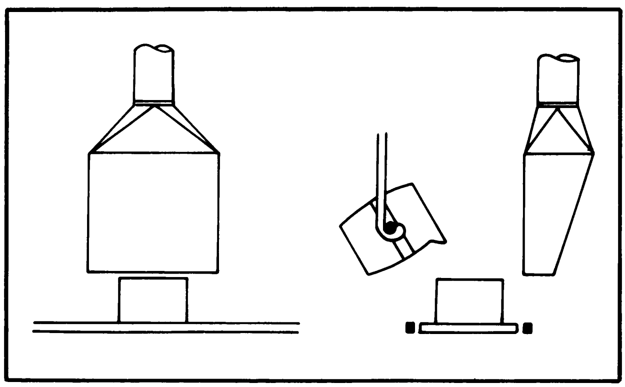


Fig. 3-4: Exhaust system examples.



2. *Pull contaminants away from workers, not through their breathing zone* (see figure for the right and wrong way).
3. *Have sufficient air speed (velocity) and volume to capture the contaminant and remove it.* Sometimes, adding hoods and ductwork to an existing system that can't handle the extra load makes the system ineffective.
4. *Have their filters, dust traps,* or *air cleaners cleaned and/or changed regularly.*

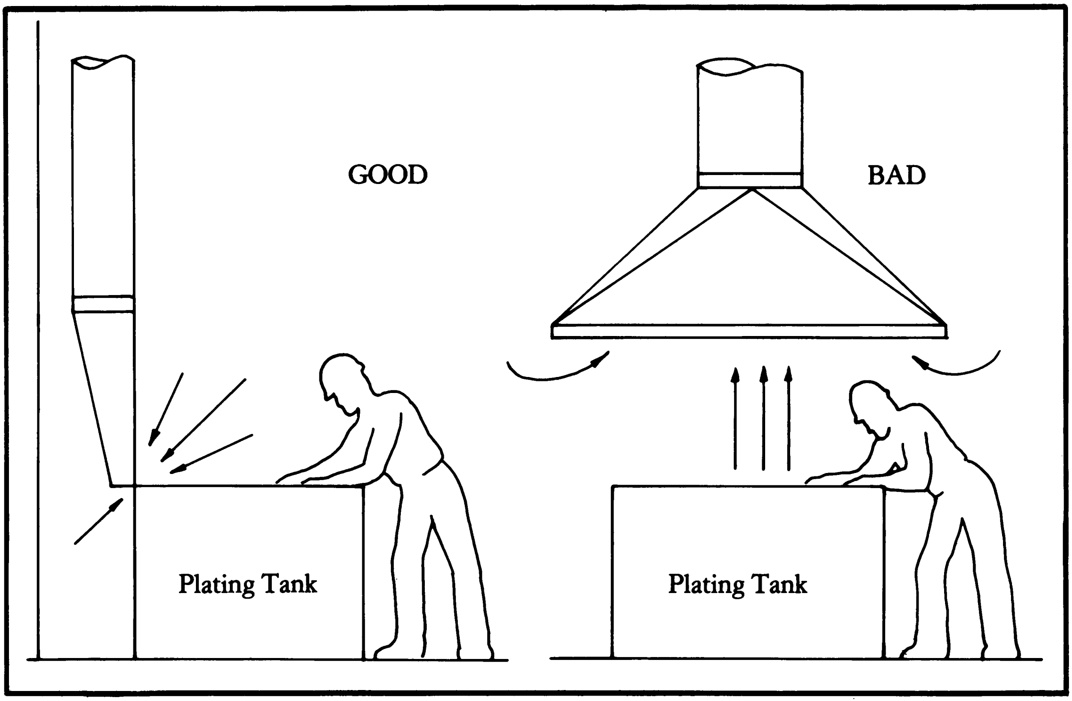


Fig. 3-5: Ventilation for contaminants.

Some foundry operations requiring ventilation are:

Sand mulling and mixing	Burning or powder washing
Furnaces	Grinding
Cupolas	Cutting
Shell core molding	Tumbling
Hot-box core molding	Blasting
Cold-cure molding	Soldering and arc welding
Shell or oil core cooling	Paint spray booths
Molding	Penetrant inspections
Pouring	Automatic heated epoxy gluing
Shakeout	Core knockout

KNOWING IF A VENTILATION SYSTEM IS OPERATING CORRECTLY

Generally watch out for:

1. Build-ups of fallout sand and other dusts around molding, core-making, grinding, blasting, and shakeout operations, or on hoppers, floors, and rafters. If these areas look dusty, the dust levels are probably excessive.
2. Visible fumes around furnaces, pouring operations, core or mold baking and cooling areas, welding, or paint-spraying operations

(The body's clues such as smell and eye irritation are discussed in Chapter 6—Hazard Identification).

PERSONAL PROTECTIVE EQUIPMENT

Workers should be provided with respirators when ventilation systems or other engineering controls cannot be used, are being planned and installed, or cannot adequately control exposures. Respirators also provide back-up protection against unexpected hazards or in emergency situations. Air-cleaning (air-purifying) and air-supplied respirators are approved for worker use by the National Institute for Occupational Safety and Health (NIOSH) and the Mine Enforcement Safety Administration (MESA). Surgical mask-type respirators are often inadequate against "respirable" particles.

AIR-CLEANING RESPIRATORS: Air-cleaning respirators draw the wearer's breathed-in air through a pad or chemical to filter out dusts or harmful gases and vapors. The respirators are equipped with replaceable filters (for dusts) or cartridges and canisters (for gases). Filters and cartridges or canisters are designed for specific substances. To select the appropriate filter or chemical cartridge, you must know:

1. What the material is
2. How dangerous it is and how it affects the body
3. The material's concentration in your work environment
4. The appropriate OSHA or state standard(s)
5. Exposure time

The filters, cartridges, and canisters all have limited lifetimes. They must be replaced before their expiration date. In addition, chemical cartridges and canisters are color-coded to identify the types of contaminants for which they work (see Table 3-5). They will *not* protect you against hazards for which they are not designed. In foundrywork you might expect to use respirators for silica, talc, asbestos, solvent vapors, gases, and metal fumes.

AIR-SUPPLIED RESPIRATORS: In these respirators, a clean air source supplies air to a face mask. Air-supplied respirators should be used when the oxygen supply is limited or when workers are exposed to extremely hazardous materials. These respirators can be positive-pressure with continuously supplied air, or negative or demand-pressure with air supplied as the worker breathes in.

The three basic typs of air-supplied respirators are:

1. *Air-line*—an outside source supplies pressurized air to a face mask or hood
2. *Air-hose*—a one-inch diameter hose supplies air to a mask, hood, or suit under normal or slightly positive pressure.
3. *Self-contained breathing apparatus*—the worker wears a bulky, heavy air tank or rebreather. Its use requires fairly extensive training.

All types of respirators may be difficult to wear: they may leak; breathing through them is difficult; they may obstruct vision; they may interfere with work; they are often misused; they may not have been adequately tested; they may be heavy. OSHA standards establish a number of guidelines for a respirator program (see Table 3-6).

Table 3-1: DUSTS PRODUCED IN FOUNDRY PROCESSES AND THEIR EFFECTS

DUST	PROCESS	EFFECTS	TLV
ASBESTOS—used on riser sleeves	Cutting to fit risers Shakeout Knockout	ASBESTOSIS: a disabling lung disease, usually appears 10 to 20 years after expsoure. SYMPTOMS include: shortness of breath lessened work capacity, tiredness, and loss of appetite MESOTHELIOMA: a rare form of cancer affecting the lining of the chest and abdomen. Usually fatal within one year after diagnosed OTHER CANCERS: increase in lung, large intestine, and rectal cancer	2 fibers per cubic centimeter of air. Fibers must be greater than 5 microns in length (1 micron = 1/25,000 of an inch)
SILICA—from mold and core sand and silica flour (mold release agent)	Mulling and mixing Core and Mold making Sandslinging Shakeout and knockout Grinding Sand handling	SILICOSIS: a disabling lung disease similar to asbestosis High exposure may make this usually chronic disease acute (miners and sandblasters are most affected)	$\frac{10\ mg/M^3}{\text{percent } SiO_2 + 5}$ (for respirable) $\frac{30\ mg/M^3}{\text{percent } SiO_2 + 2}$ (total dust)
TALC—from talc mold-release agent	Molding Coremaking Shakeout Knockout	TALCOSIS: a disabling lung disease similar to silicosis TALC may contain asbestos fibers	More than 1 percent quartz: use silica limit Less than 1 percent quartz: use 20 Mppcf For fibrous talc use asbestos limit

Table 3-2: FUMES PRODUCED IN FOUNDRY PROCESSES AND THEIR EFFECTS

FUME (METAL)	FOUNDRY AND OPERATION	EFFECTS	TLV
ALUMINUM	Aluminum foundry -melting, pouring, cleaning, torch cutting, and welding	Not generally regarded as an industrial hazard	
	-alloy with copper, zinc, manganese, magnesium, and silicon	Some reports of lung scarring associated with long-term exposures to fine dust	15 mg/M^3 Respirable: 5 mg/M^3
BERYLLIUM	Aluminum, Brass and Bronze foundries -melting, pouring, and cleaning -alloy with copper	ACUTE: irritant to eyes, nose, throat and lungs CHRONIC: berylliosis, a disabling lung disease that also affects other organs—can cause death; causes cancer in lab animals	0.002 mg/ M^3
CADMIUM	Brass and Bronze foundries -copper contaminant -in silver solder	ACUTE: irritant to nose, throat, and lungs; pulmonary edema (lungs fill with fluids) CHRONIC: kidney and liver damage; emphysema (lung damage); anemia	Fume: 0.1 mg/M^3 Dust: 0.2 mg/M^3
CHROMIUM	Iron foundry	ACUTE: chromium and oxides—mild irritants; chromic acid (dichromate)—skin ulcers, nose ulcers, holes in walls separating nasal canals (chrome nose) CHROMIC ACID (dichromate)—skin ulcers, nose ulcers, holes in walls separating nasal canals (chrome nose)	Metal and insoluble salts: 0.1 mg/M^3 Soluble salts: 0.5 mg/M^3

FUME (METAL)	FOUNDRY AND OPERATION	EFFECTS	TLV
COBALT	Aluminum and Iron foundries -melting, pouring, and cleaning -alloy (with nickel, copper, beryllium, molybdenum, chromium, and aluminum—produces high strength and high temperature properties)	ACUTE: allergic asthma-like or skin reactions CHRONIC: lung disease	0.1 mg/M^3
COPPER	Aluminum, Brass, and Bronze foundries -alloy (bronze)	ACUTE: stuffy nose, nose ulcers, eye irritation; nausea, stomach pain, and diarrhea from inhaled fumes	Fume: 0.1 mg/M^3 Dusts and mists: 1.0 mg/M^3
IRON OXIDE	Iron foundries -melting, pouring and welding	Not considered highly toxic. ACUTE: metal fume fever (flu-like symptoms) CHRONIC: abnormal x-rays	10 mg/M^3
LEAD	Brass Foundries -melting, pouring -dust from grinding, chipping -impurities in copper castings -solder with tin	CHRONIC: Highly toxic : anemia, stomach cramps and pains, nerve function disturbances; can affect both male and female reproduction.	0.2 mg/M^3 (new OSHA-recommended level: 0.1 mg/M^3)

FUME (METAL)	FOUNDRY AND OPERATION	EFFECTS	TLV
MAGNESIUM	Iron and Magnesium foundries -alloys	Extreme fire hazard from dusts, flakes, chips, scraps. ACUTE: magnesium oxide—metal fume fever	15 mg/M^3 (new OSHA-recommended level: 10 mg/M^3
MANGANESE	Manganese, Steel, and Bronze foundries	ACUTE: irritant CHRONIC: permanently disabling lung and nervous system disease; cirrhosis of the liver.	5 mg/M^3
MERCURY	Aluminum foundries -alloy	CHRONIC: tremors, memory loss, psychological disturbances; kidney damage.	1 mg/M^3
NICKEL	Steel and Nickel foundries -Nickel carbonyl -other nickel-containing alloys	ACUTE: metal and salts—skin problems (dermatitis) and allergic skin reactions. Nickel carbonyl (more dangerous than nickel)—systemic effects on lungs, stomach, nervous system; death. CHRONIC: (nickel carbonyl)—lung irritation and lung cancer	Nickel: 1 mg/M^3 Nickel carbonyl: 0.001 mg/M3
PHOSPHORUS	Bronze foundries	Ignites spontaneously unless stored under water. ACUTE: toxic to liver, jaundice. CHRONIC: bone degeneration; ulcers.	0.1 mg/M^3 (yellow)
TELLURIUM	Iron and other foundries -alloys (with copper, steel, tin, lead, cast iron)	No serious toxic effects. ACUTE: garlic breath; drowsiness; loss of appetite; nausea.	0.1 mg/M^3

FUME (METAL)	FOUNDRY AND OPERATION	EFFECTS	TLV
THALLIUM	Iron foundries -lead and zinc contaminant -melting and pouring	ACUTE: allergic skin reaction; nervous system disorder; death (with large doses); suicide. CHRONIC: baldness; nervous system disorder.	0.1 mg/M^3
TIN	Aluminum, Brass, and Bronze foundries -common alloy (with aluminum and lead)	Nondisabling lung condition from dust	2 mg/M^3
ZINC	Aluminum, Brass, Magnesium foundries -welding	ACUTE: zinc oxide—metal fume fever or "zinc chills"	5 mg/ M^3
ZIRCONIUM	All foundries -molding and core making -foundry sand, abrasives -alloys	ACUTE: powder burns from dusts; Inhalation possibly toxic	5 mg/ M^3

Table 3-3: GASES PRODUCED IN FOUNDRY PROCESSES AND THEIR EFFECTS

GAS	PROCESS	SOURCE	EFFECTS	TLV
AMMONIA	Hot box resin process	Nitrate catalyst, Ammonium Chloride	ACUTE: irritant to eyes, nose, mouth, and often lungs	50 ppm
BCME (Bis-chloromethyl ether)	Resin process	Formaldehyde and Hydrogen Chloride	LUNG CANCER	NO TLV Keep exposures as close to 0 as possible
CARBON DIOXIDE	Combustion	Pouring, cooling, shakeout Decomposition product of resins	Displaces oxygen in air causing suffocation (asphyxiation)	5,000 ppm
CARBON MONOXIDE	Incomplete combustion	Cupola, casting cooling Fork lifts, pay and front-end loaders Melting, pouring, shakeout Decomposition product of resins	ACUTE: prevents oxygen from reaching vital organs (heart and brain) by combining with hemoglobin, the oxygen carrier of the blood; first symptom usually headache	50 ppm (new NIOSH-recommended level: 35 ppm)
CYANIDE			ACUTE: suffocation by interfering with blood's oxygen-carrying ability; skin rash CHRONIC: appetite loss, headache, weakness, nausea, and dizziness Decomposes to hydrocyanic acid	5 mg/M^3 (S)**
HYDROGEN CHLORIDE	Resin process	Decomposition product	ACUTE: irritant to eyes, skin, mouth, nose, throat, and lungs; acid burns (see BCME)	5 ppm (C)*

*(C) indicates the exposure limit is a ceiling value.

**(S) indicates the substance can also be absorbed through the skin

GAS	PROCESS	SOURCE	EFFECTS	TLV
HYDROGEN SULFIDE		Decomposition product of sulfonic acid catalyst	ACUTE: irritant to eyes, nose, throat, and lungs; pulmonary, edema; headache, dizziness, excitement; inability to breath CHRONIC: bronchitis, blurred vision, weight loss.	10 ppm
NITROGEN DIOXIDE	Welding	Nitrogen in air converted to nitrogen dioxide at high temperatures	ACUTE: irritant to eyes, nose, and throat; forms nitric acid in lungs, causing them to fill with fluid (pulmonary edema); death CHRONIC: pneumonia; chronic irritation of respiratory tract; headache; loss of appetite	5 ppm
SULFUR DIOXIDE	Combustion	Sulfur-containing compounds	ACUTE: irritant to nose, throat, lungs, skin, and eyes CHRONIC: Lung scarring	5 ppm
OZONE	Welding X-ray inspection	Oxygen in the air converted to ozone	ACUTE: irritant to eyes, mouth, nose, throat, and lungs; Pulmonary edema; death CHRONIC: serious lung disorders	0.1 ppm
FLUORINE	Aluminum casting Welding "Rimmed steel" foundries	Liberated from sodium fluoride in casting Fluxes for brazing and gas welding	ACUTE: strong irritant—may destroy tissues of skin, eyes, nose, throat and lungs; Pulmonary edema CHRONIC: pain; stiffening, and crippling due to bone changes	0.1 ppm

Table 3-4: VAPORS PRODUCED IN FOUNDRY PROCESSES AND THEIR EFFECTS

VAPOR	USE	SOURCE	EFFECTS	TLV
ACROLEIN		Thermal decomposition of sand-binding oils	High flammable and explosive—potentially very dangerous	0.1 ppm
EPOXY RESINS	Patterns	Grinding and cutting of cured resins	ACUTE: irritant to skin, throat, lungs, nose and eyes	Only 5 have TLVs
ETHANOL (ethyl alcohol)		No-bake phenolic resins	ACUTE: allergic skin rash and asthma-like condition—reaction, once it occurs will always occur on re-exposure Some affect nervous system and other symptoms or organs	
FORMALDEHYDE			ACUTE: mild skin irritant; drunkenness from high levels	1,000 ppm
		No-bake resins released during curing -furan acid resin -phenolic acid resin	ACUTE: severe irritant to eyes, nose, mouth, throat, and lungs Allergic skin reaction	3 ppm
FURFURYL ALCHOL		Urea-formaldehyde resins	CHRONIC: lung irritation	
		Hot-box resins No-bake resins -furan acid resins phenolic acid resins	ACUTE: irritant to skin, mouth, eyes, and nose Mild nervous system problems (shakes)	50 ppm: (new NIOSH-recommended level: 5 ppm)

VAPOR	USE	SOURCE	EFFECTS	TLV
FURAN RESIN		Same as furfuryl alcohol	Same as furfuryl alcohol	Same
HEXAMETHYL-ENETETRAMINE (HEX)	Accelerator	Cold-curing resins	Liberates ammonia and formaldehyde when heated ACUTE: irritant to nose, mouth, skin, and lungs Allergic skin reaction	NO TLV
ISOPROPYL ALCOHOL	Solvent used to remove phenolic resins from skin	Cleaning operations	ACUTE: mild skin irritant; drunkenness, similar to ethanol	400 ppm
LINSEED OIL	Sand binder	Molding Casting cooling	BURNING PRODUCES DANGEROUS DECOMPOSITION PRODUCTS* Mild skin irritant	NO TLV
MELAMINE	Resins	Melamine-formaldehyde resins Phenolic and amino resins	BURNING PRODUCES DANGEROUS DECOMPOSITION PRODUCTS* ACUTE: skin irritant	NO TLV

VAPOR	USE	SOURCE	EFFECTS	TLV
METHANOL (methyl alcohol)	Solvent	Cleaning operations	Flammable ACUTE: mild irritant to skin, mouth, throat, and eyes CHRONIC: blindness (usually from drinking)	200 ppm
PHENOL	Resins	Phenolic acid resins Phenolic urethane resins	ACUTE: irritant to skin and lungs CHRONIC: serious liver, kidney, and nervous system damage	5 ppm
PHOSPHORIC ACID (actually a mist)	Resin catalyst	Phenolic resins	ACUTE: burns or irritates skin, eyes, throat, and lungs	1 ppm
SULFONIC ACID (actually a mist)—including toluene-sulfonic and benzene sulfonic acid	Resin catalyst	No-bake resins phenolic acid resin furan acid resins	ACUTE: burns or irritates skin, eyes, throat, and lungs	NO TLV
SULFURIC ACID (actually a mist)	Resin catalyst	Phenolic Resins	Highly toxic ACUTE: strong irritant to skin, eyes, nose, throat, and lungs; can burn skin, throat, and lungs	1 mg/M^3

VAPOR	USE	SOURCE	EFFECTS	TLV
TRICHLORO—ETHYLENE	Solvent	Cleaning operations	ACUTE: irritant to eyes, nose, and throat kidney and liver damage CHRONIC: kidney and liver damage; recently shown to produce cancer in laboratory animals	100 ppm
TRIETHYL AMINE		No-bake resins	ACUTE: irritates eyes, skin, nose, throat, and lungs	25 ppm
UREA		Urea-formaldehyde resins	BURNING PRODUCES DANGEROUS DECOMPOSITION PRODUCTS*	NO TLV
URETHANE (ISOCYANATES: MDI AND TDI)		No-bake resins -alkyd-isocyanate -phenolic urethane	ACUTE: allergic skin and asthma-like reactions—once the asthma-like condition has appeared, any additional exposure, no matter how minute, will trigger the reaction	TDI and MDI—0.02 ppm
VEGETABLE OIL	Binder	Molding Casting cooling	BURNING PRODUCES DANGEROUS DECOMPOSITION PRODUCTS* Mild skin irritant	NO TLV

*NOTE: Most resins will emit as decomposition products of burning—carbon monoxide, carbon dioxide, and hydrocarbons. (For a discussion of the health effects of these products, see the sections on gases and vapors in Chapter 3 and Tables 3-3 and 3-4).

Table 3-5
COLOR CODE FOR GAS-MASK CANISTERS (ANSI K13.1-1967)

ATMOSPHERIC CONTAMINANTS TO BE PROTECTED AGAINST	COLORS ASSIGNED
Acid gases	White
Hydrocyanic acid gas	White with ½-inch *green* stripe completely around the canister near the bottom
Chlorine gas	White with ½-inch *yellow* stripe completely around the canister near the bottom
Organic vapors	Black
Ammonia gas	Green
Acid gases and ammonia gas	Green with ½-inch *white* stripe completely around the canister near the bottom
Carbon monoxide	Blue
Acid gases and organic vapors	Yellow
Hydrocyanic acid gas and chloropicrin vapor	Yellow with ½-inch *blue* stripe completely around the canister near the bottom
Acid gases, organic vapors, and ammonia gases	Brown
Radioactive materials, excepting tritium and noble gases	Purple (Magenta)
Particulates (dusts, fumes, mists, fogs, or smokes) in combination with any of the above gases or vapors	Canister color for contaminant, as designated above, with ½-inch *gray* stripe completely around the canister near the top
All of the above atmospheric contaminants	Red with ½-inch *gray* stripe completely around the canister near the top

*Gray shall not be assigned as the main color for a canister designed to remove acids or vapors.

NOTE: Orange shall be used as a complete body, or stripe color to represent gases not included in this table. The user will need to refer to the canister label to determine the degree of protection the canister will afford.

Table 3-6
RESPIRATORY PROTECTION
(from the *Federal Register,* June 27, 1974 Vol 39: No. 125, 29CFR, 1910.34)

In the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors, the primary objective shall be to prevent atmospheric contamination. This shall be accomplished as far as feasible by accepted engineering control measures (for example, enclosure or confinement of the operation, general and local ventilation, and substitution of less toxic materials). When effective engineering controls are not feasible, or while they are being instituted, appropriate respirators shall be used pursuant to the following requirements.

Requirements for a Minimal Acceptable Respirator Program

1. Written standard operating procedures governing the selection and use of respirators shall be established.

2. Respirators shall be selected on the basis of hazards to which the worker is exposed.

3. The user shall be instructed and trained in the proper use of respirators and their limitations.

4. Where practicable, the respirators should be assigned to individual workers for their exclusive use.

5. Respirators shall be regularly cleaned and disinfected. Those issued for the exclusive use of one worker should be cleaned after each day's use or more often if necessary. Those used by more than one worker shall be thoroughly cleaned and disinfected after each use.

6. Respirators shall be stored in a convenient, clean, and sanitary location.

7. Respirators used routinely shall be inspected during cleaning. Worn or deteriorated parts shall be replaced. Respirators for emergency use such as self-contained devices shall be thoroughly inspected at least once a month and after each use.

8. Appropriate surveillance of work area conditions and degree of employee exposure or stress shall be maintained.

9. There shall be regular inspection and evaluation to determine the continued effectiveness of the program.

10. Persons should not be assigned to tasks requiring use of respirators unless it has been determined that they are physically able to perform the work and use the equipment. The local physician shall determine what health and physical conditions are pertinent. The respirator user's medical status should be reviewed periodically (for instance, annually).

11. Approved or accepted respirators shall be used when they are available. The respirator furnished shall provide adequate respiratory protection against the particular hazard for which it is designed in accordance with standards established by competent authorities.

4

PHYSICAL HAZARDS

A. NOISE

Noise is a constant hazard in the foundry environment, particularly in larger foundries. It is literally everywhere. Some work areas such as automatic core molding, casting cleaning, and mechanical shakeout produce higher noise levels than others. (Table 4-1 below lists some foundry processes or equipment that may generate high noise levels). Foundries are often divided into core room, cleaning room, and foundry area, but there are generally no barriers to prevent noise from travelling throughout the plant. Foundry workers are affected by noise from the machines they operate as well as "area" noises from combined noise sources.

Table 4-1

SOME NOISY FOUNDRY PROCESSES

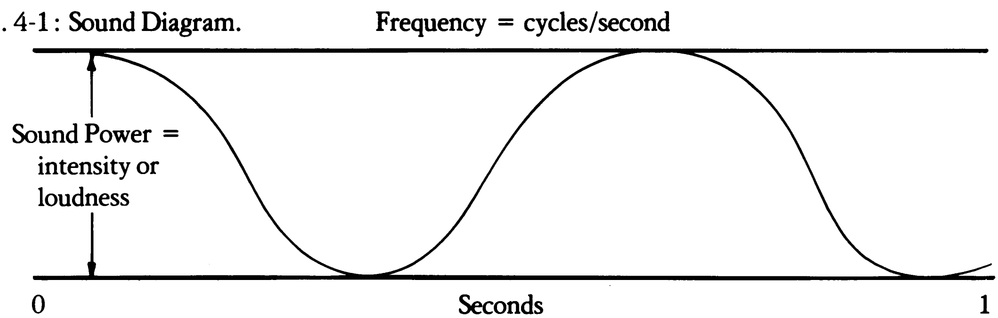
Blasting, all types	Electric Arc Furnace
Casting Cleaning	Molding
Core Blowing	Pneumatic Chipping
Core Knockout	Sand Slinging
Grinding	Shakeout

The shakeout and cleaning room areas are usually the noisest foundry areas. Molding and core-making processes also produce excessive noise levels. Workers in these areas should be particularly aware of the possible hazards.

WHAT IS NOISE?

Noise is essentially unwanted sound. As sound, it travels in waves and can be measured by its *loudness* (or intensity) and its *pitch* (or frequency). Pitch is measured in cycles per second or Hertz (Hz), while loudness is measured in decibels (dB).

Fig. 4-1: Sound Diagram.



The decibel unit may be confusing because it is a relative term. 0 decibels is the minimal sound a person with "good" hearing can hear in a quiet room. Decibels are based on powers of ten, so a 10-decibel increase means the sound or noise is ten times more powerful, although it may not sound that much louder. To illustrate: normal speech is around 60 decibels; traffic at 70 decibels is 10x louder than speech; the decibel level fifty feet from a pneumatic drill is 80, or 100x louder than speech; a 90 decibel sound is 10x10x10 or 1,000x louder than speech; an electric arc furnace (100 dB) is 10,000x louder than speech; and a casting shakeout area at 110 dB is 10x10x10x10x10 or 100,000x louder than ordinary speech (and so on).

The current federal and CAL/OSHA standard for noise exposure is 90 dB averaged over an 8-hour day; higher exposures have separate limits (see Table 4-2 below). Many foundry operations exceed the standard (see Table 4-3 below).

Table 4-2

OSHA PERMISSIBLE NOISE EXPOSURE

Sound Level—Decibels on "A" Scale	Hours/Day
90	8
92	6
95	4
97	3
100	2
102	1½
105	1
110	½
115	¼

Table 4-3

FOUNDRY PROCESSES AND TYPICAL NOISE LEVELS

Casting Cleaning	97-99 dB
Core Molding	92-105 dB
Chipping	95-115dB
Electric Arc Furnace	105dB
Grinding	95-110 dB
Molding	90-115 dB
Pneumatic Chipping	95-110 dB
Sand Slinging	90-95 dB
Shakeout	93-115 dB
Tumbling	100-115 dB

HOW DOES NOISE AFFECT HEARING?

The ear is a remarkable part of the body, funneling sound waves through the ear canal (external ear) to the eardrum and middle and inner ears. When sound waves hit the ear drum, it vibrates in proportion to the sound's loudness and frequency. In the middle ear, the body's three smallest bones (hammer, anvil, and stirrup) hit against each other, transmitting the sound further to an inner ear drum. In the inner ear, sound waves pass through a snail-shaped structure (cochlea) containing tiny hair cells (nerve fibers). The hair cells bend in proportion to the sound's loudness, transmitting impulses through a series of nerves and finally to the brain. There, the message is decoded and we hear a particular sound. Figure 4-2 shows the pathway through the ear.

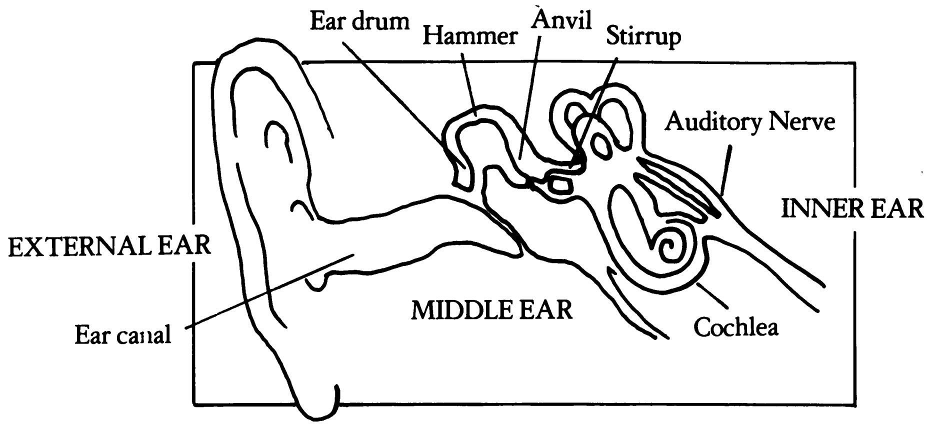


Fig. 4-2: Ear diagram.

Excessive exposure to noise is dangerous. The eardrum can be immediately ruptured by a high impact noise, for example, from a shotgun. High, continuous noises from molding machinery or air compressors exhaust the tiny hair cells in the inner ear, eventually wearing them out and reducing hearing ability.

Initial exposure to high noise levels causes a *temporary* hearing loss. During a break from operating an automatic core or molding machine for awhile, you may notice you can't hear so well as usual. This is a temporary loss. If exposure to high noise levels continues, however, the loss may become *permanent. Permanent noise-induced hearing losses are irreversible.* They are not correctable by hearing aids or surgery.

WHAT ARE THE OTHER EFFECTS OF NOISE?

Acting as a stress factor, noise can cause certain body changes: blood pressure and heart beat rate increase; more adrenalin is pumped through the body; you may feel irritable, tired, or nervous. Some research indicates that with continuous exposure noise may eventually contribute to problems with the circulatory (heart and blood vessels) and gastrointestinal (stomach, intestines, etc.) systems.

Noise also interferes with communication and may block out warning signals. You want to be able to *hear* an approaching forklift's horn or a co-worker's warning that something is about to fall on your head.

HOW DO YOU KNOW IF YOU'RE BEING OVEREXPOSED?

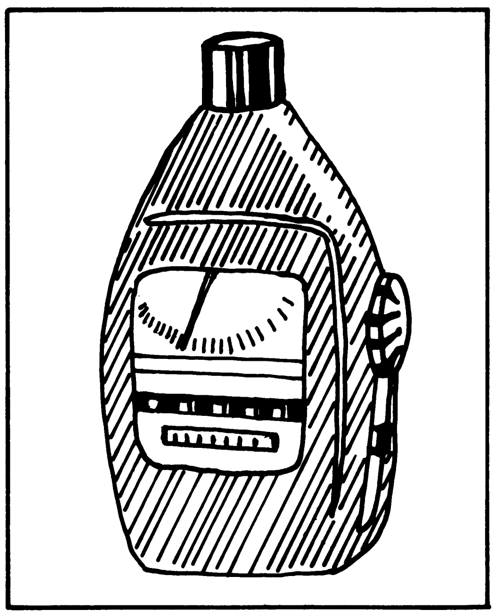
A good rule of thumb to follow—if you can't hear a co-worker talking an arm's length away from you, the noise level is probably too high. That is, it's above the 90 dB standard. There are also more sophisticated ways to measure noise.

The basic noise-measuring instrument is the SOUND LEVEL METER; it measures continuous noise only (see Figure 4-3 below). Measuring impact noises is more complicated; use an impact noise analyzer or oscilloscope.

The sound level meter measures the loudness of noise in decibels. It is held at ear level, away from the body and usually at right angles to the noise source. Normally, an industrial hygienist or safety engineer does noise measurements and analyzes the results, but many workers are now learning to use the sound level meter. If you think you are being exposed to too much noise, request a sampling and ask to see the results.

If you work in a noisy area, you should also have a yearly hearing exam, called an audiometric test. This test measures your ability to hear sounds of varying loudness and frequency. It should be performed at least 24 to 48 hours after noise exposure has ceased. The results are recorded either automatically or manually on a chart (audiogram) like the one pictured in Figure 4-4 .

Fig. 4-3: Sound level meter.



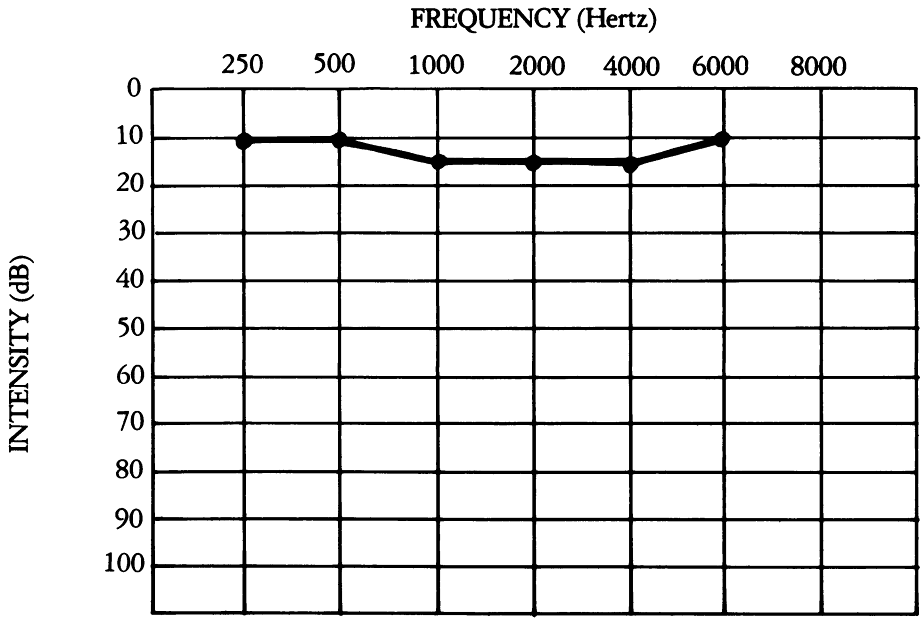


Fig. 4-4: Audiogram.

Points to look for on your audiogram, and to compare to earlier and succeeding tests are:

1. A drop at 4,000 Hz—this is the first point at which a noise-induced hearing loss shows up.
2. Any drop or shift to other frequencies—this indicates you are losing more of your hearing. When the loss is in the 500-3,000 Hz range, you will have trouble understanding normal speech.

HOW DO YOU CONTROL NOISE?

Noise can be controlled at its source, in its path, or at the receiver. The most effective point to control noise is at its source; the least effective is at the receiver.

Engineering controls at the noise's source—modifying machinery, confining noise-producing equipment in insulated rooms, changing work processes to quieter ones—reduce the hazard by actually reducing the noise level produced (see Table 4-3 for examples).

Table 4-3

EXAMPLES OF FOUNDRY NOISE CONTROLS

Noise Source	Possible Control Method
Tumblers	Enclosure Lining with Rubber
Chipping	Scarfing as Substitute Process
Shakeout	Enclosure Bumpers
Grinders	Mufflers
Riveting	Crimping as Substitute Process
Dumping Castings into Tubs	Double Bottom Tubs

Noise can be controlled in its path by: sound-treating work areas, floor, and ceilings to reduce noise reflection; increasing distances between worksites and noise sources; and erecting barriers between noise sources and receivers.

The least effective place to control noise is at the receiver. To control noise at the receiver, workers can be rotated or wear personal protective devices such as ear muffs and plugs. However, rotating workers is probably not a very effective means to control noise exposure in foundries since work processes are rarely enclosed. Ear plugs and muffs are also not very satisfactory protections, although they should be used where necessary while engineering controls are being installed or during emergencies. Both can cause discomfort; ear plugs may not fit properly and possibly cause infection. *Never* plug your ears with such materials as cotton; they do ***not*** effectively decrease exposure.

B. HEAT

Most foundry workers are normally exposed to high temperatures, particularly in the shakeout, core knockout, furnace, pouring, and ladle preheating areas.

HOW DOES EXCESS HEAT AFFECT THE BODY?

The body can normally rid itself of excess heat, primarily through evaporation (sweat evaporating from the skin). When the body absorbs more heat than it can get rid of, the body becomes stressed; it can't compensate for this imbalance. To cope with heat stress the body becomes acclimatized—that is, over a period of time (usually about 1 week) the body makes internal adjustments reducing the strain normally felt when exposed to high temperatures. However, acclimatized workers can still be seriously affected by hot environments.

Several major disorders may result from exposure to excess heat:

1. HEAT CRAMPS. The muscles used to perform a job develop painful spasms—usually in the arms, legs, and abdomen.
2. HEAT EXHAUSTION. Usually caused by loss of body water, this disorder results in headache, tiredness, nausea, giddiness, and sometimes fainting.
3. HEAT STROKE. The most serious heat disorder, heat stroke results from sweat suppression and increased storage of body heat. The condition is characterized by hot, dry skin, high temperature (usually above 106°F and rising), mental confusion, loss of consciousness, convulsions, and eventually coma. *Heat stroke is usually fatal unless treated PROMPTLY AND ADEQUATELY* (see Chapter 8, First Aid).

Other possible effects include heat rash or "prickly heat," which develops when the body is exposed to humid heat and the skin is covered by unevaporated sweat, and heat *syncope*—fainting due to high heat exposure. Workers with heart disease will be less able to tolerate heat than others.

HOW DO YOU DETERMINE HEAT EXPOSURE?

A worker's exposure, or *heat stress value,* is determined from: worksite temperature; radiant heat; air moisture; rate of worker's body moisture evaporation (sweat); how strenuous the work is (workload); and rate of air movement. To measure air temperature and air moisture, and to simulate the body's moisture evaporation rate, a single thermometer, the WET BULB GLOBE THERMOMETER (WBGT), or three separate thermometers can be used.

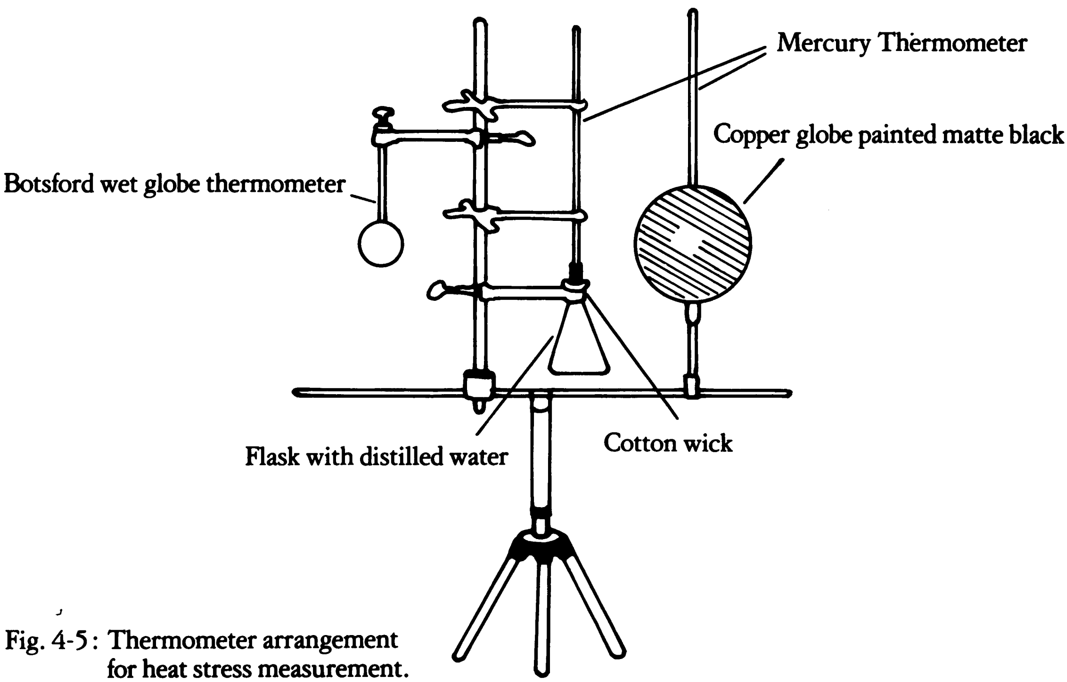


Fig. 4-5: Thermometer arrangement for heat stress measurement.

A heat stress standard proposed by OSHA's Standard Advisory Committee takes into account WBGT temperature, workload, and air movement.

HOW DO YOU CONTROL HOT ENVIRONMENTS?

Workers can be protected by controlling heat either at its source or at the worker. Most effective is modifying heat-producing machinery by engineering controls. Heat control methods include:

1. ENGINEERING CONTROLS AT THE HEAT SOURCE: actually reduces the amount of heat thrown into the work environment, by
   a) ventilation
   b) insulation (though this is often asbestos) of furnaces and boilers
   c) dehumidifiers
   d) reflective shielding

2. ENGINEERING CONTROLS AT THE WORKERS: protects workers most affected by a particular heat source without reducing the heat thrown into the foundry environment. Enclosing workers in temperature-controlled booths is a good example. However, this method may not be very practical in foundries.

3. JOB ROTATION: reduces individual cumulative exposures by limiting time in a hot area without modifying actual heat production or the exposure intensity. This is an acceptable method to reduce individuals' heat exposure.

4. EMPLOYER-PROVIDED PROTECTIVE CLOTHING: protects individuals without modifying actual heat production. To be effective, clothing must be adequate for the amount of heat generated by the worker's body while performing the job, and allow workers the types of movements required by their jobs.

C. RADIATION

Certain foundry processes release radiation in the form of visible light, ultraviolet rays, infrared rays, x-rays, and gamma rays. Overexposure to these forms of radiation can have a variety of damaging effects, ranging from skin burns to cancer.

1. IONIZING RADIATION

X-rays and gamma rays (from isotopes such as Cobalt-60) are often used in the inspection area to detect flaws in large castings. When these rays pass through matter they excite the atoms (building blocks of all matter) changing them into electrically charged particles called *ions*—hence the term *ionizing radiation.* The standard for exposure to ionizing radiation, 5 Rems, is for cumulative (added up over a long period) exposure.*

*A rem takes into account the dose of radiation and how much the particular radiation can affect the body.

Ionizing radiation's effects depend upon dose (intensity of exposure x length of exposure), type of radiation, and the sensitivity of various parts of the body to the particular radiation form. Exposures and their resulting effects can be *acute* (short term at excessively high concentrations) or *chronic* (long term, at lower concentrations). Acute exposures to high radiation levels are rare and will probably not occur in foundry operations; such levels would occur after an atomic blast. The effects of acute exposure on the body may include:

Decreased number of red and white blood cells

Decreased number of platelets (necessary for blood clotting)

Appetite loss, nausea and internal (stomach) bleeding

Brain and nerve damage (requires extremely high doses and is always fatal)

Chronic effects may result from high or low level radiation exposures but take a number of years to appear.

Leukemia and thyroid cancer

Shortened life span

Genetic effects (mutations) on the cells which determine characteristics passed on to future generations. Both male and female workers can be affected. Genetic damage can result in abnormalities in the exposed worker's children or future descendants, stillbirths, or the inability to conceive a child.

To measure their exposures to ionizing radiation, all potentially exposed workers should wear film badges or dosimeters. Exposure can also be monitored with devices such as Geiger counters. To protect workers against the effects of ionizing radiation:

1. Shield castings with lead during inspections.

2. Have only trained workers inspect castings.

3. Rope off or barricade inspection areas to prevent unnecessary exposures.

4. Mark inspection areas with the Energy Research and Development Administration's (ERDA) purple and yellow radiation symbol.

Fig. 4-6: ERDA Symbol.

2. NONIONIZING RADIATION

Nonionizing radiation, both infrared (IR) and ultraviolet (UV), is given off during melting, pouring, and welding operations, and during penetrant or magnaflux inspections. Both IR and UV radiation can injure the skin and eyes. Conditions resulting from overexposure are listed below in Table 4-5.

Table 4-5

INFRARED	ULTRAVIOLET
Skin Burn Increased Production of Pigment	Sunburn—ranging from simple reddening to severe blistering
Burning and blistering of eyelid Continuous exposure may produce chronic inflamation	Conjunctivitis—an inflammation of the membrane surrounding the eye
Cataracts—the lens of the eye becomes cloudy, hampering vision	Welders Arc Eye or Eye Flash—an effect on the cornea (the outer covering of the front part of the eye) which causes a sandy or gritty feeling in the eye

Nonionizing radiation is measured by sophisticated equipment usually operated by an industrial hygienist or other trained personnel.

To protect individuals from exposure, employers should provide:

1. Tinted goggles or preferably full face shields (particularly for welding)

2. Gloves and protective clothing covering all exposed skin

3. Curtains or screens around operations generating nonionizing radiation, particularly UV. The curtains or screens will protect other workers in the area.

5

SAFETY HAZARDS

Accidents are unforeseen incidents interrupting normal work progress and possibly causing injury. They occur commonly in foundries. Though we distinguish between health (physical and chemical) and safety hazards for convenience, health hazards oftentimes interact with safety hazards to increase the possibility that an accident will occur. For example, carbon monoxide can increase a forklift operator's accident potential by reducing concentration powers and attention span, and dulling physical and visual reflexes. Injuries usually produce immediately visible effects from obvious causes. In contrast, occupation-related diseases take time to develop, often from cumulative exposure; they may *not* have a single, easily identifiable cause.

A. MATERIALS' HANDLING

Foundry workers manually lift and transport many heavy materials. Back problems are the most frequently reported injury for most foundry workers. Foundry workers always face the possibility of back strain due to incorrect lifting and carrying methods or to carrying too heavy a load.

Back injuries can be eliminated by using correct lifting procedures, and by not lifting or carrying more than you can comfortably handle. To lift correctly:

1. Keep back straight
2. Bend knees to pick up load. Never bend from the waist
3. Lift load with back straight, taking the load's weight first with the knees, then the hips
4. Straighten slowly; *do not shift the weight onto the back*

Always test an object before attempting to lift and carry it. GET HELP IF IT IS TOO HEAVY; USE MECHANICAL LIFTING AIDS WHERE POSSIBLE.

Other injuries associated with improperly handling materials are amputations, fractures, bruises, and cuts caused by heavy objects dropping on the feet or other body parts. Workers carrying objects such as mold flasks and core boxes can injure others as well as themselves. Poor housekeeping and maintenance—leaving obstructions such as tools and scraps in aisles, wet and slippery floors or stairs, unguarded floor openings and stairways—can cause workers to trip and fall and contribute to accidents.

To prevent injuries due to falling objects, get help if an object is too heavy or bulky to carry comfortably by yourself. In addition, your employer should insure that:

1. Aisleways are clearly marked and kept clear of obstructions

2. Floor openings are guarded by railings or covered

3. Stairways have approved railings

4. Walking-working surfaces such as floors, stairs, etc. are kept dry and free from obstruction

Some materials' handling in foundries is mechanized. Conveyor belts and overhead cranes move sand, additives and binders, ladles, coke, metal scrap, finished cores, core boxes, molds, etc. to the appropriate foundry area. These materials may also be transported by fork lifts and front-end loaders. Although they eliminate injuries due to manual lifting and carrying, these machines can create other hazards: materials can fall from conveyors; workers can be caught in conveyor openings; forklifts and loaders can produce carbon monoxide (see Chapter 3 for exposure effects); forklifts and loaders can run into workers and injure them; materials on overhead cranes can break loose and fall on workers below, particularly if the cranes are overloaded.

These problems can be eliminated by:

1. Guarding conveyor belts on all sides

2. Using electric forklifts, or at least regularly servicing and maintaining gas and diesel forklifts (a well-tuned engine emits less carbon monoxide than a poorly tuned one)

3. Equipping forklifts with horns, back-up signals, lights, and overhead and load guards

4. Having only trained persons operate forklifts

5. Clearly marking and never exceeding capacities on forklifts and overhead cranes

6. Frequently inspecting crane cables and hoists to insure they are not worn out or unsafe

B. HAZARDS DUE TO MACHINERY

Modern foundries have been automated and mechanized to a large degree, eliminating many hazards created by manual lifting and materials handling. However, workers in mechanized operations face new hazards. Foundry workers suffer a high rate of amputations, fractures, and crushing injuries from being caught in, under, or between machines, and eye injuries from flying objects or dusts. Machine-related injuries may be caused by:

1. Unguarded machines

2. Irregular maintenance and jury-rigged repairs

3. Frames left unblocked while patterns are being replaced

4. Machines left operable while being repaired

5. Workers not wearing protective equipment such as safety shoes, glasses, or hard hats

To eliminate many machine-related health and safety hazards, *employers should provide:*

1. *Two-handed operating controls* on core blowing or molding machinery to protect workers against having their limbs caught by the machinery. Such controls force the operator to use both hands at once to operate the machine.

2. *Guards* on core-box push cylinders, counterweight cable pulleys, wheel guides, and table adjusting pads

3. *Automatic barrier guards* between operators and machines

4. *Regular equipment maintenance,* including procedures for red-tagging machines in need of repair

5. *Tag-out or lock-out procedures* for machines being repaired to insure they won't be operated

6. *Frame-blocking procedures* for patterns being changed to prevent mold tables from falling and trapping workers

7. *Chains on compressed-air hoses* to prevent them from whipping around and severely injuring workers

8. *Safety glasses* when there's a risk of flying objects, especially near sand slinging operations

9. *Safety shoes* and *hard hats* when there's a risk of falling objects

C. FURNACES AND OVEN OPERATIONS

Furnaces and ovens, especially iron foundry cupolas, can be sources of exposure to hazardous dust fumes, and vapors, and the location of serious, even fatal accidents.

1. CUPOLA FURNACES

Cupolas are vertical refractory-lined furnaces which melt iron and iron-containing metals by contact with burning coke. The most hazardous cupola activities are: charging, tapping, dropping the cupola bottoms, and repairing. The furnace emits huge amounts of carbon monoxide, so chargers should be especially aware of the hazards due to carbon monoxide and have access to respirators in case of emergency.

CHARGING

Charging the cupolas can be exceedingly dangerous. Accidents frequently occur due to:

1. Overloaded and unevenly loaded barrows tipping back on chargers' feet
2. Materials falling onto workers from materials'-handling equipment
3. Moisture-filled scrap cylinders and drums blowing up on contact with molten material or coke
4. Workers falling from charging floor (perhaps overcome by carbon monoxide)

The solutions to these problems are fairly obvious:

1. Never overload barrows or buggies
2. Surround areas under materials'-handling equipment with rails or guards
3. Break open all scrap materials before charging
4. Provide standard railings and toeboards around all charging platform openings
5. Rivet platform flooring in place; make sure flooring is substantial
6. Place guard rails across manually charged cupola openings

TAPPING

The major hazards associated with tapping are burns and eye damage due to ultraviolet radiation. Worker protections include:

1. Wearing personal protective gear such as goggles, protective clothing, and gaiter-type boots or shoes
2. Making sure there are no moisture sources nearby such as faucet or sprinkler leaks

3. Keeping workers not involved in tapping operations beyond a 12-foot radius while tapping is going on

DROPPING THE CUPOLA BOTTOM

The cupola bottom is dropped at the end of each shift, so all materials left in the furnace can be emptied onto a layer of dried sand or refractory material (heat resistant bricks or cement). Many accidents occur due to workers being caught under the cupola when the bottom is dropped or to the cupola doors sticking or only opening part way. Standard and emergency procedures should be established for opening the cupola bottom. Before opening the cupola bottom, standard procedures should include:

1. Inspections to make sure no moisture has seeped into the sand underneath the cupola (otherwise explosions could occur)

2. Inspections to make sure that no workers are underneath or within 12 feet of the cupola area before or during the dropping

3. Barriers around the area under the cupola to keep workers out and to protect those opening the cupola bottom

4. Signals warning workers in the area that the cupola bottom is being dropped

For cases where the door fails to open or only partially opens, *emergency procedures* should include:

1. Evacuating *all* workers out of the area

2. Providing a temporary guard (if cupola is not charged manually) around the charging door before dropping demolition balls into the furnace

3. Cooling the cupola to a safe temperature before attempting to cut the doors open, if other methods have failed

REPAIRS

Workers repairing cupolas, usually relining them with new refractory material, can be injured by materials dropping through the charging hole or by being overcome by carbon monoxide. Standard procedures for entering and working inside the cupola should include:

1. Installing guard rails over charging openings

2. Posting signs over the charging openings that workers are inside

3. Breaking off all loose slag and bridges before relining cupolas

4. Checking for weak shells that could increase the explosion risk

5. Checking the cupola atmosphere for carbon monoxide before entering

6. Continuously monitoring the cupola for carbon monoxide while workers are inside

7. Providing safety harnesses so that workers can be evacuated quickly in case of emergency

8. Adequately ventilating cupolas

9. A respirator-equipped standby worker observing those inside the cupola

10. Available respirators

2. CRUCIBLE FURNACES

Crucible furnaces are much less hazardous than cupolas, particularly if adequately vented to remove metal fumes and toxic gases. Problems associated with these furnaces occur mainly due to:

1. Cracks in the crucible releasing molten metal

2. Manually lifting the crucible, causing overexertion and accidents

These problems can be avoided by:

1. Regularly inspecting all crucibles for cracks, flaws, and moisture

2. Charging and handling the crucibles carefully to prevent new cracks or fissures from forming

3. Using mechanical devices to handle heavy crucibles, especially to remove them from the furnace

3. OVENS

Core-drying and mold-drying ovens release smoke, gases, and metal fumes into the foundry environment. When their vertical sliding doors are unsafe and counterweights unguarded, nearby workers may be injured. Flashback from fire boxes and explosions in gas-fired ovens may cause injury.

Accidents and overexposures to toxic airborne materials can be prevented by:

1. Erecting guards around fire pits

2. Installing safe vertical doors and frequently inspecting them

3. Installing exhaust ventilation near oven doors to keep concentrations of dust, fumes, gas, and smoke below hazardous levels

4. Regularly inspecting flues to prevent flashback from fire boxes

5. Installing explosion vents on core ovens

6. Inspecting ovens, pilot lights, blowers, and fans before lighting ovens

D. HOUSEKEEPING

Poor housekeeping can contribute to both health and safety hazards in foundries. Some frequent effects of housekeeping problems are:

1. TRIPPING, CUTS, SCRAPES, AND BROKEN BONES—scrap metal, tools, pallets, etc. left in aisles or other inappropriate locations

2. SILICOSIS, TALCOSIS, AND OTHER LUNG PROBLEMS—dusts not cleaned up regularly or properly (with an effective vacuum system or by wet sweeping)

3. BURNS—hot slag left on floors

4. BURNS—hot molds left unprotected on the floor

5. BURNS—open flames

6. TRIPPING—gas lines left on floors

7. TRIPPING—compressed air hoses left lying across the floor

8. SLIPPING—floors left wet and muddy

9. FALLS—uncovered holes in floors

10. FALLS—uneven floors

To avoid injury due to poor housekeeping:

1. Clearly mark aisles and remove scrap materials at regular intervals

2. Store tools and materials in their proper locations

3. Never clean up dusts by dry sweeping and compressed air—employers should provide a vacuum system or wet-sweeping methods

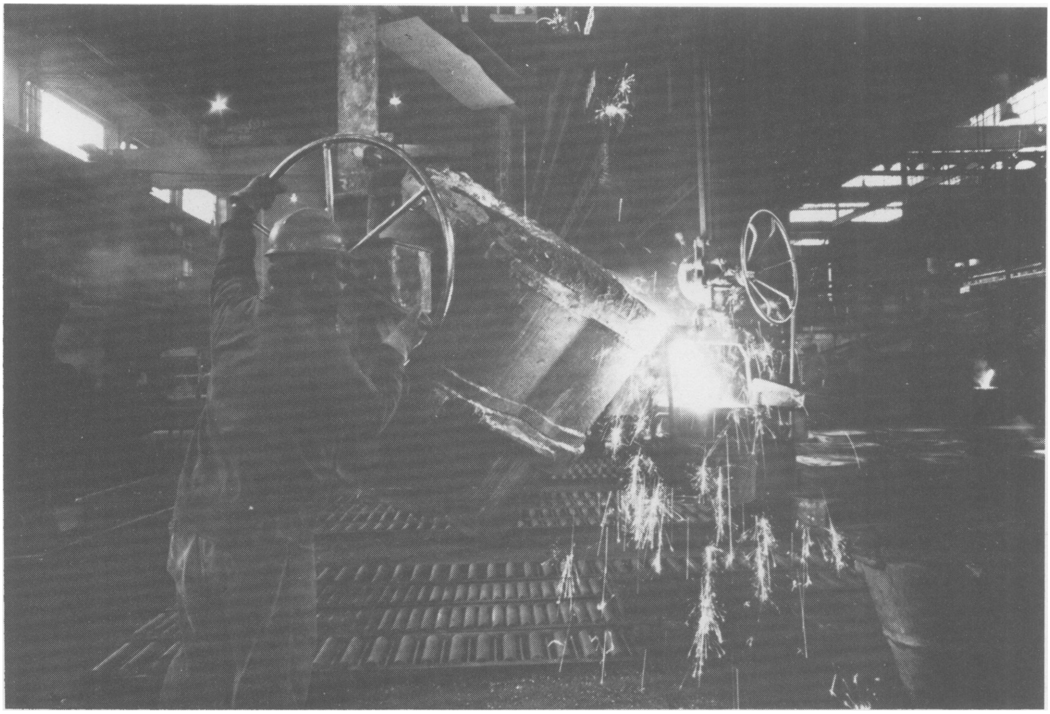
4. Keep hot molds and cores in a specific area where workers will not be able to contact the hot metal

5. Wear personal protective equipment (provided by employers) such as safety shoes and hard hats when there is danger of falling objects

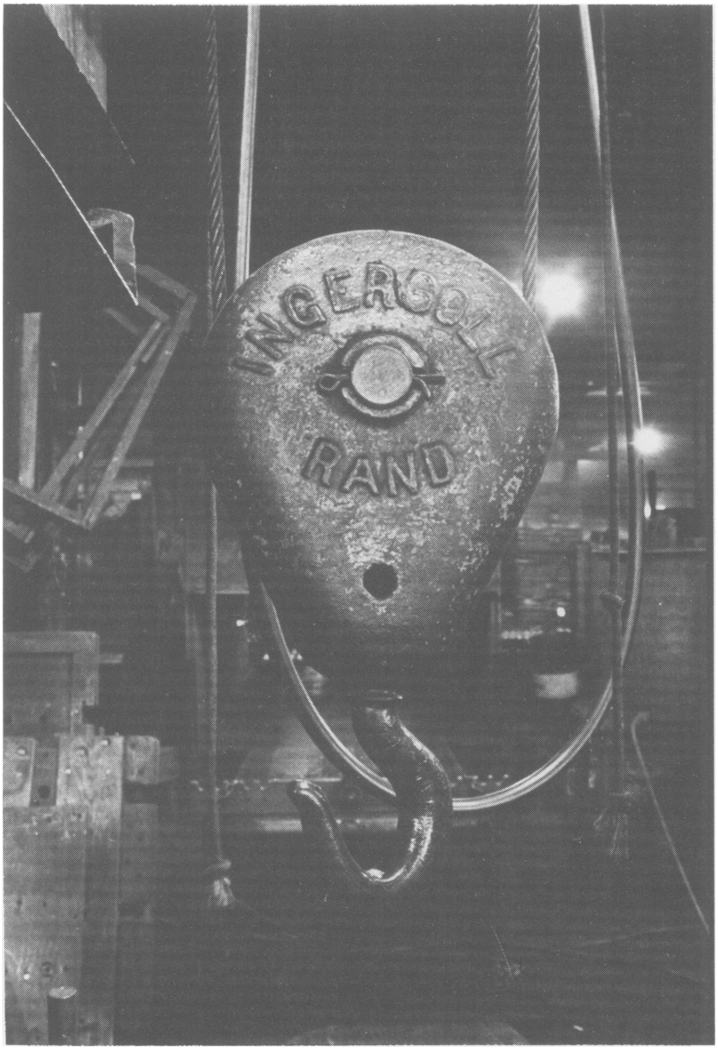
This chapter does not cover all the safety hazards possible in a foundry. By using the methods described in the next chapter—Hazard Identification—you should be able to pick out additional problems in your workplace.

Foundry food and drink vending areas are often close to operations producing toxic dusts, gases, fumes, and vapors.

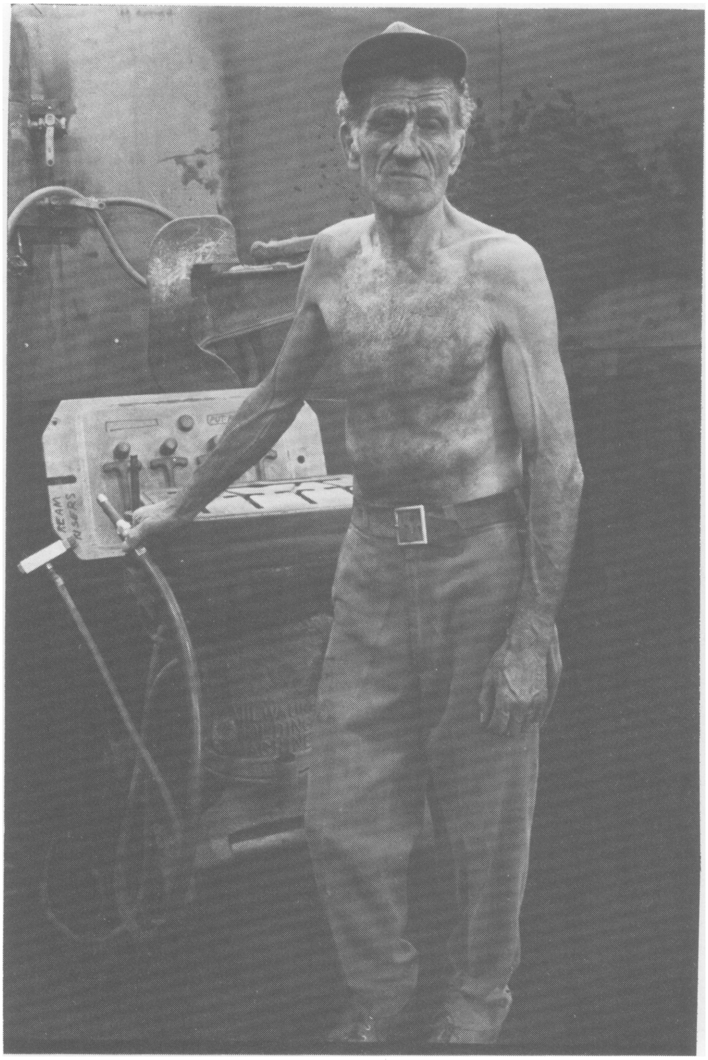
Foundry worker flanked by a large ladle containing molten metal and an electric arc furnace (to the right).



Molten metal, here being poured into a small casting on the pouring floor, produces fumes and invisible ultraviolet and infrared radiation.

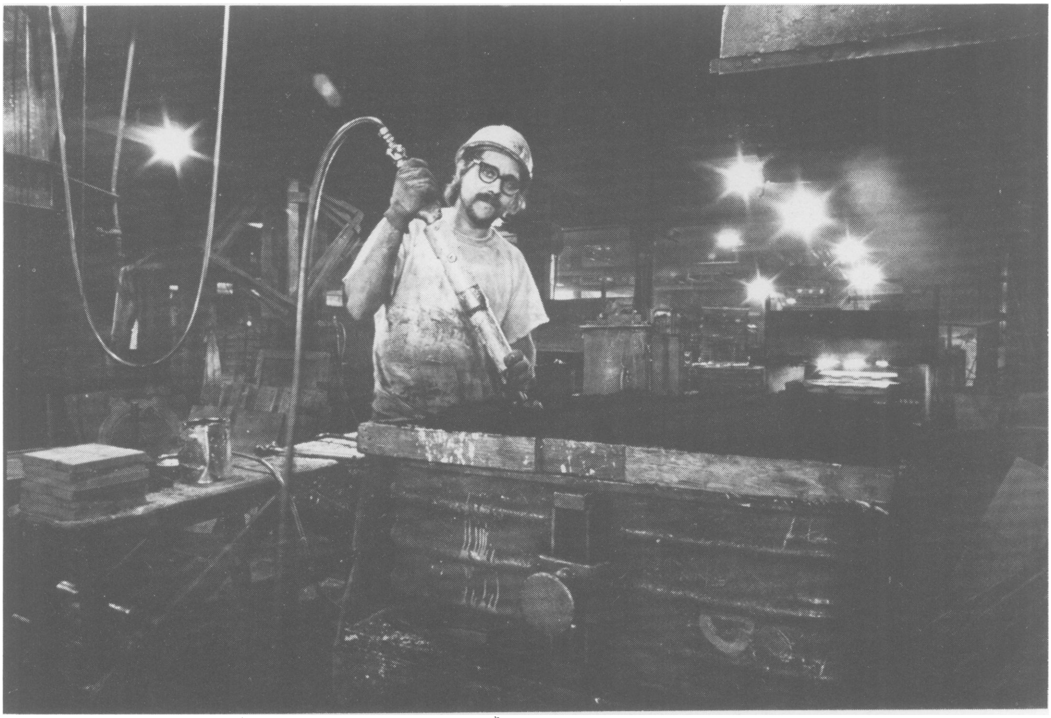


Overhead cranes move ladles and castings throughout the foundry. Overloaded cranes and worn hoists or cables are frequent causes of accidents.



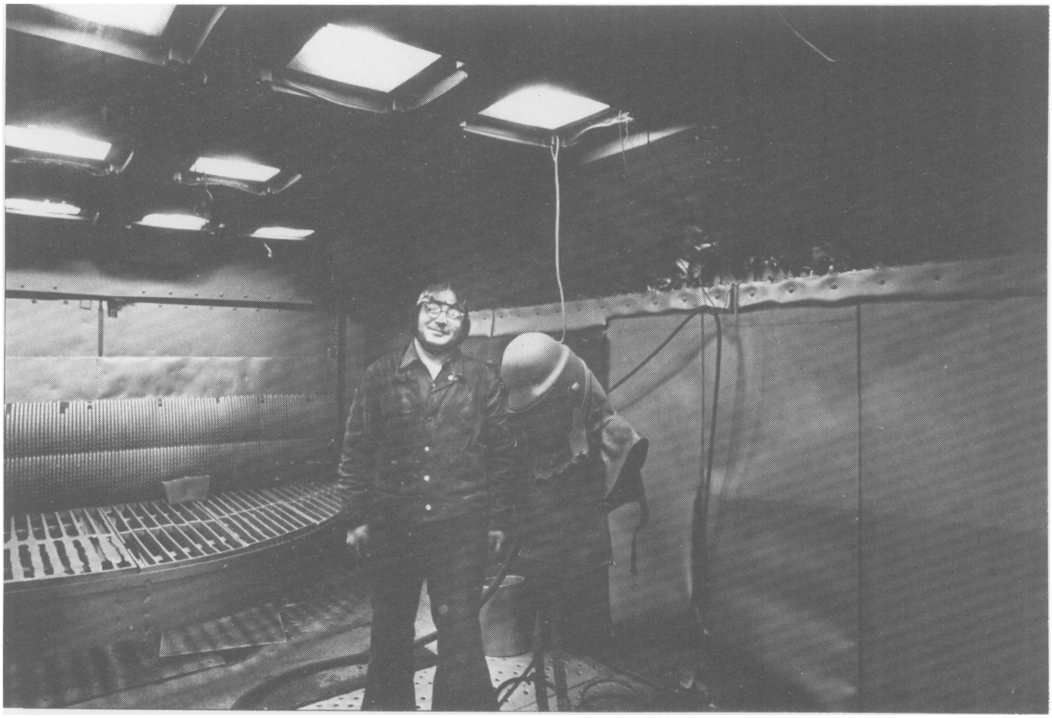
A molder, dressed as he normally works, stands before his molding machine. Many foundry operations create enormous amounts of heat.

A molder packs sand into a mold with a tamper.



This molder's hands have been crushed by molding equipment.

A sandblaster poses in the sandblasting room, his protective suit on the right. Blasting sand contains a high percentage of silica.



The grinding wheels used by this worker to smooth castings produce high concentrations of silica dust.

6

HAZARD IDENTIFICATION

You don't have to be an expert to inspect your workplace. If given basic instruction, anyone can learn to spot work hazards. Those best qualified to identify potentially dangerous situations in the work environment are those dealing with them daily—workers.

A hazard may be obvious, questionable, or hidden. Questionable and hidden hazards are perhaps the most dangerous since they are the least easily recognized.

OBVIOUS hazards could be: unguarded machinery, broken ladder rungs, or oil spills on the floor.

QUESTIONABLE hazards could be: uncertified fire extinguishers, fork lifts without lift capacities marked, no emergency evacuation procedures, or no certified first-aid kits.

HIDDEN hazards could be: faulty equipment, overloaded cranes, faulty alarm systems on explosive meters or toxic gas warning systems, odorless gases such as carbon monoxide, or invisible "respirable" dusts.

Chapters 3-5 in this manual discussed some of the potential hazards in foundries. To identify the hazards that actually exist in your workplace, ask yourself the following seven questions. Be sure to consider all obvious, questionable, and hidden possibilities.

1. IS THERE SOMETHING ABOUT MY JOB THAT FRIGHTENS ME?

2. DO MY CO-WORKERS PERFORM TASKS THAT APPEAR DANGEROUS TO ME?

3. HAVE I HAD ANY INJURIES, OR NEAR MISSES THAT COULD HAVE INJURED ME?

4. HAVE I EVER CHANGED A PROCEDURE TO AVOID A POTENTIAL INJURY?

5. DO I TAKE RISKS I FEEL ARE PART OF THE JOB?

6. HAVE I EVER ASKED FOR HELP WHEN I FELT A JOB WAS UNSAFE TO PERFORM ALONE?

7. HAVE I EVER REFUSED TO PERFORM AN ASSIGNED TASK BECAUSE I FELT IT WAS HAZARDOUS?

Once you've answered these questions, you should keep a list of the answers. Getting feedback from co-workers or comparing your list with others will provide you with even more information.

Even with these seven questions, you may have overlooked some crucial job-related hazards. The following list does not cover all the possibilities. It does indicate the types of conditions you should evaluate.

GUARDS:	Is it possible to start a machine by accident? Would doing so be dangerous? Can the equipment be oiled without removing the guards? Will the machinery be shut down if guards are removed? Can machinery be made inoperable, for example by securing switches in the off position, during repair and maintenace? Is this normally done?
WIRING:	Are any wires exposed? Do wires cross aisles or working surfaces? Are electrical outlets overloaded? Is all electrical equipment properly grounded? Are combustible solvent containers properly grounded?
TRAINING:	Does your job include appropriate safety training? Do you receive periodic follow-up training on safe work practices?
FLOORS:	Are work areas or aisles cluttered? Do floors have holes—if so, are they guarded or covered? Are floors ever slippery or wet? Are floors regularly swept or cleaned by vacuum methods? Is the working surface adequate for the weight it carries? Does every worker have access to an exit? Is it possible to be struck by passing vehicles because aisles or roadways are not clearly marked?
MATERIALS HANDLING:	Can improper handling, or the lack of mechanical handling equipment such as cranes and hoists, cause strains? Can materials be reached (are they stored in proper areas) without leaning near dangerous equipment? Do cranes, lifts, and hoists have their load capacities clearly marked? Are aisles sufficiently wide for materials' handling vehicles? Do internal combustion and diesel-fueled machines put out fumes near workers? Is equipment periodically weight-tested and certified? Is equipment properly maintained and repaired?
PERSONAL PROTECTIVE EQUIPMENT	Are workers provided with protective clothing and equipment when needed? Is protective equipment properly maintained? Are workers trained to properly use and care for protective equipment? Is the use of protective equipment enforced?
SANITATION:	Do departments have sufficient toilet and washing facilities? Are there showers and a locker room? Are there eye-wash stations? Is there a clean place to eat, removed from possible exposure to toxic materials?
HEAT:	Does the work area get so hot that you feel faint and dizzy? Do you get periodic headaches from the heat?
AIRBORNE HAZARDS:	Is dust visible in the air or settled on rafters, around conveyors, mixers, mullers, or molding and coremaking machinery? Are fumes visible around melting and pouring operations; around welding and casting cleaning areas? Are materials-handling vehicles such as fork lifts and front-end loaders used? Are they serviced

regularly? Are solvents used for washing? Are the solvents stored in open containers? Are salamanders used in confined spaces? Do large quantities of slag wool form at the cupola? Is there a regular housekeeping program? Is smoke visible at casting cooling and shakeout or knockout operations? Are ventilation systems provided? Are the systems tested regularly? Do visible dusts or fumes escape around the ventilation system? (See Chapter 3 for more information about ventilation systems).

Warnings for many health hazards are not as obvious as those for safety hazards, but they do exist. Health hazards are often more serious than accident hazards. Substances causing mild symptoms now could have serious long-term effects. Headaches, recurring coughs and colds, sore throat, dizziness, stomach problems, and constant fatigue are symptoms that should not be ignored. They may be caused by work conditions.

Pay attention to the way your body reacts to your work environment, and find out if your co-workers have had similar experiences. This information could prove to be a valuable clue to pinpointing a hazard, and might later help you prove a condition is work-related. Following is a list of symptoms and known causes. Keeping a notebook of symptoms and possible causes is useful for tracking down work-related health hazards.

SYMPTOMS	COMMON CAUSES	ORGAN OR SYSTEM AFFECTED
Skin redness, dryness and and itching	Solvents and Degreasers, Plastics, Epoxy Resins, Cutting Oils, Fiberglass	Skin
Ringing, temporary deafness	Excessive Noise	Ears
Redness, pain, irritation, tearing	Smoke, Irritating Gases, Metal Dusts, Acids, Caustics	Eyes
Sneezing, coughing, sore throat, running nose	Irritating Gases (ozone, ammonia, etc.), Dusts, Metal Fumes, Vapors	Nose, Throat
Wheezing, flu-like symptoms, shortness of breath	Metal Fumes, Silica, Asbestos, Talc	Lungs
Dizziness, headaches, sleepiness	Solvents, Degreasers, Carbon Monoxide, Asphyxiant Gases (CO_2, Acetylene, etc.)	Nervous System

7

MEDICAL SCREENING

The foundry hazards listed in the tables in chapter 3 can all cause medical problems. To determine any health effects, workers exposed to such substances should have periodic medical examinations. Detecting health problems early may increase the possibilities of treatment and recovery.

Medical examinations consist of a medical history, a physical examination, and laboratory or x-ray tests. Occupation-related medical exams should also include an occupational history and discussion of substances used in the workplace. Problems such as dermatitis can be identified with a physical examination. Others require a combination of physical examination, laboratory tests, and x-rays. Knowing the substances to which you are being exposed, their possible health effects, and your symptoms will enable your physician to administer appropriate tests.

Even seemingly minor symptoms—frequent headaches after work or at work though not at home, eye irritation or strain, red or itchy skin, shortness of breath (especially if experienced at work though not at home), weight loss, tiredness, and any difference between work and home symptoms—could be indications that something serious is developing.

Since most physicians (even company-retained) are not trained in occupational medicine, it is up to workers to tell physicians the substances to which they are being exposed and all possibly relevant symptoms.

Physical examinations alone can determine problems due to nose, throat, mouth, and eye irritants such as ammonia, phenol, or hydrogen chloride. Physical examinations plus lung function and patch tests may be required for materials such as epoxy compounds which cause allergic skin sensitization and asthma-like reactions if inhaled. Chest x-rays and lung function tests should be performed to detect lung damage due to dusts such as silica, asbestos, an ı talc, and certain chemicals. These tests are especially important for foundry workers. Specific b! l and urine tests detect liver and kidney damage due to solvents, or measure the content of suc metals as mercury and lead. Special blood tests detect blood damage due to carbon monoxide and similar substances. Special physical examinations, tests, or x-rays detect other problems. (Since some of the tests mentioned above may be unfamiliar, an explanation follows the laboratory section).

THE PHYSICAL EXAMINATION

A physical examination can be either *complete* or *specific*. Complete examinations look at all parts of the body. They are either brief or exhaustive. Complete exams take from 10 to 25 minutes per patient, excluding history-taking or laboratory-testing time. Specific examinations look at only pertinent portions of the body. For example, a specific examination for a sprained ankle would not cover the lungs unless they had been involved in the injury.

Specific occupation-related exams are oftentimes more valuable than complete physicals *if* the examining physician knows what to look for and which tests to use.

LABORATORY SCREENING

Current medical practices now rely on the laboratory to a very great extent. However, *laboratory tests are not always exact;* a certain number of normal results may actually be abnormal, and vice versa. Interpretation of any laboratory results should be reviewed by someone who understands all potential pitfalls. Also, *laboratory tests should be specific to determine the effects of specific exposures.*

Important things to consider when evaluating any laboratory screening program are:

1. Are the tests specific and appropriate for my potential diseases? Are they sensitive enough to uncover disease?

2. Are the persons performing and evaluating the tests qualified?

3. Will the test results be specific to my problem or general?

4. Will I be told the test results? The medical record belongs to the examined individual even when an employer has paid for testing and evaluation. Individuals may request test results directly from the testing physician or have their private physicians request their records.

Obviously the more workers know about their occupation-related exposures, the more they can insure adequate screening.

EXAMPLES OF LABORATORY TESTS

Blood Tests:

(When a blood test is performed and the result is normal, that means only the result of that specific test is normal. Others may not be normal or may not have been performed at all).

a. Chemistry tests indicating normal or abnormal liver, kidneys, heart

b. White and red blood cell counts (hematology tests)

X-Rays:

a. Chest x-rays using 14 x 17 inch film are the only satisfactory ones; using miniature pictures is not adequate. X-rays of other body parts should be avoided unless specifically indicated

b. Do not use back x-rays to screen out workers susceptible to back injuries; this practice *only* exposes workers to excessive radiation

Lung Function Tests:

One measure of the lung's ability to move air is done with an instrument called a spirometer. All foundry workers exposed to hazards such as silica, asbestos, MDI, etc. should have a spirogram taken

Cytology Tests:

Detect cancer. The most common version is the cervical Pap smear. Occupation-related cytology tests are done of the lungs from sputum smears or of the urinary bladder from urine samples

Urine Tests:

Indicate the kidneys' state and other general body conditions. Also detects certain metals such as mercury and lead

Electrocardiogram (EKG) Test:

Measures heart function and indicates heart problems or coronary artery disease. Some physicians and others believe that doing a *stress electrocardiogram* (performed while the person being tested is running on a treadmill) on people without heart disease symptoms is much more effective than the usual EKG performed with the patient lying down.

8

FIRST AID

First aid is the immediate and temporary care given the victim of an accident or sudden illness until adequate medical care can be obtained. Having some knowledge about first aid can be life saving. Often, no one with medical training is present at an accident or onset of sudden illness. *The following general first aid principles are by no means a detailed course.* (Complete first aid courses are offered by the Red Cross and by local YMCAs and YWCAs. Certified first aid instructors can be hired by union health and safety committees to offer courses to members. The American National Red Cross text, *First Aid,* is available in most book stores and can be bulk ordered from the Red Cross).

Many injuries are minor, requiring nothing more than cleansing and a band-aide. More serious injuries may involve severe bleeding, heart (cardiac) failure, breathing difficulties, choking, poisoning, head injuries, or broken bones. First, stop bleeding and determine whether artifical respiration is necessary. Then determine additional problems. Move injured persons as little as possible and only after you know what parts of the body have been injured. Always support injured parts when moving persons. Avoid compounding the injury.

To offset shock as much as possible, keep the victim's body temperature from falling, preferably with blankets. Never heat the victim. Call a physician or ambulance or obtain medical advice on the phone as soon as possible.

Additional pointers include:

1. Identify *all* injuries not just the most obvious; give first aid to minor as well as major injuries.

2. If victim is unconscious or partly conscious, do not: attempt to rouse; give fluids; or lift by the belt.

3. To allow good breathing if victim is unconscious and there is no apparent fracture, loosen clothing about the neck. Unless the victim has suffered a head or neck injury, turn patient on his side and maintain this position by flexing a leg (or both legs). Place a pillow under the head so secretions can drool from the corner of the mouth. Clear dentures, vomit, or other materials out of the mouth to allow air to move.

4. With indoor accidents, beware of opening windows if weather is cold unless noxious gases are present and may have caused the patient's condition.

5. Leave diagnosing the patient's condition to medically trained persons.

6. Reassure victim.

7. Obtain victim's name and address if possible.

WOUNDS AND BLEEDING

Several problems can arise from scrapes, cuts, and puncture wounds. Scrapes (abrasions) tend to be more painful than dangerous. Clean with soap and water. Cuts (lacerations) may have sharp, smooth edges caused by a knife or sharp instrument, or a ragged, rough appearance caused by crushing. Clean with soap and water, then join raw edges of the wound together with a band-aide for small cuts, stitches or suturing may be required for more serious cuts.

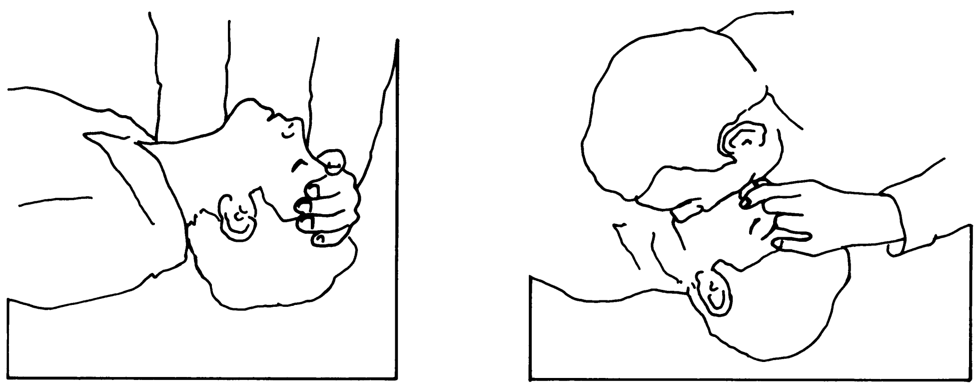
Avoid using antiseptics such as iodine. These substances tend to do more harm than good by destroying living body cells.

To stop profusely bleeding wounds, directly apply pressure with some sort of clean cloth or bandage. Do not use tourniquets. The only exceptions are severe injuries, such as major amputations.

ARTIFICIAL RESPIRATION

Mouth to mouth resuscitation is the preferred method. Remove foreign objects from victim's mouth. Lay victim on his back, extending the head backwards to arch the back and clear the air passage. Place your mouth over the victim's mouth. Hold the victim's nose closed to prevent leakage. Breathe hard and fast into the victim's mouth; allowing air to be exhaled between your breaths. Continue until victim can breathe on his own, or an ambulance has arrived and victim has been hooked up to a mechanical breathing device.

Fig. 8-1: Mouth-to-mouth resuscitation.



CARDIAC RESUSCITATION

If the victim lacks a heart beat, a second person should give cardiac resuscitation while the first is giving artificial respiration. With sharp, brisk motions push down on the chest over the breast bone (sternum), pushing from your shoulders and keeping your arms straight. Be careful not to push too hard; you could break bones or cause internal injuries. The ratio of chest pumps to breaths should be 3:1.

SHOCK

Shock can be very serious. When in shock, the body is unable to maintain a proper metabolic balance. The condition is characterized by shallow breathing, weak pulse, pale skin, cold clammy skin, dilated pupils, nausea, even vomiting. Persons suffering from shock may be conscious or unconscious. If not brought out of shock, the victim will likely die. Unless he has suffered a head injury, place shock victim on his back with his legs elevated; cover with a blanket to keep warm. If the shock victim has also suffered a head injury, elevate the head and shoulders to prevent too much blood and pressure in the head.

HEAD, NECK, AND BACK INJURIES

If moved inexpertly, a person with a broken neck or back can become permanently paralyzed. Never move such a person unless you *know* what to do.

FRACTURED BONES

Immobilize the broken bone, being careful not to injure the victim more by moving the broken area. Boards and belts can be used to immobilize legs. The body can be used as a splinting aid, for example by tying a broken wrist or forearm to the chest to prevent movement or by strapping a broken leg to the uninjured leg.

EYE INJURIES

Promptly wash out chemicals splashed into the eyes with large amounts of water. Have medical personnel examine all eye injuries and remove foreign bodies.

POISONING

Unless poisoned by gasoline or similar petroleum products or by caustic products, force the victim to vomit. Vomiting (as well as ingesting) petroleum products may cause victims to develop a particular type of pneumonia from inhaling the vapors. If you cannot induce vomiting, give the victim milk to reduce the poison's absorption from the stomach. Milk of Magnesia, tea, and burned toast are no longer considered "universal antidotes." Do not force vomiting in an unconscious or groggy person.

BURNS

Burns may be first, second, or third degree. In first degree burns such as sunburn, the skin reddens. In second degree burns, the skin blisters. In third degree burns, all layers of the skin are destroyed.

First and second degree burns are painful. Third degree burns are the most dangerous, leaving the body without a protective covering; bacteria and infections can enter and vital fluids escape. Treat first and second degree burns with ice, then clean and keep clean. Keep third degree burns clean and covered until adequate medical care can be obtained.

CHEMICAL BURNS

Many chemicals, both acids and alkalis, can burn the skin. Dilute the chemical's potency by flushing the burn with large amounts of water. Obtain medical treatment immediately.

ELECTROCUTION

Electrical shock sends the heart into a nonbeating pattern of electrical activity called ventricular fibrillation. This can be fatal. To treat an electrical shock victim, first make sure he is removed from the electrical tool or apparatus by unplugging the tool, cutting off the electricity, or similar methods. If these aren't possible, attempt to knock the victim from the current. Use only *nonconducting* instruments, such as a piece of wood. Otherwise, you may become part of the current and be electrocuted yourself. If victim's heart is not beating, use a quick thump or pound on the chest to properly resuscitate.

FIRST AID KITS

First aid kits should be available in all workplaces. The main thing to remember is that first aid kits should meet your potential needs. Commercially manufactured "uniform" first aid kits are available in 16, 24, or 32 units. Each unit contains one or more complete individual dressing(s) sealed in sterile wrappers. Contents can be selected to meet the purchaser's particular needs. 24-unit kits contain:

2 units—1" Adhesive Compress
2 units—2" Bandage Compress
2 units—3" Bandage Compress
2 units—4" Bandage Compress
1 unit—3" x 3" Plain Gauze Pads
2 units—Burn Ointment
1 unit—Eye Dressing Packet
4 units—½ sq. yard Plain Abosrbent Gauze
3 units—24" x 72" Plain Absorbent Gauze
4 units—Triangular Bandage
1 unit—Tourniquet - scissors - tweezers

(The Red Cross first aid courses and text instruct you in how to use these items)

Kits found in drugstores are satisfactory *only* if their contents: (1) are sufficient, (2) are arranged so users can quickly find items without unpacking the entire kit, and (3) are wrapped so unused portions don't become dirty through handling or exposure to air.

9

OCCUPATIONAL SAFETY AND HEALTH LEGISLATION

On December 29, 1970 Congress enacted the OCCUPATIONAL SAFETY AND HEALTH ACT (OSH Act) into law (P.L. 91-596) to "assure so far as possible every working man and woman in the Nation safe and healthful working conditions and to preserve our human resources..." The OSH Act encourages employers and employees to *reduce hazards* in the workplace and initiate *new* or *improve* existing safety and health programs. The law also:

1. Authorizes the Occupational Safety and Health Administration (OSHA) to set mandatory safety and health standards

2. Provides for an effective enforcement program

3. Encourages states to administer and enforce their own occupational safety and health programs if *at least as effective* as the federal program. (As of June 1976 22 states had such plans—most states with state plans have an Industrial Relations Department that can provide information on state procedures).

A. WHO IS COVERED

The OSH Act covers every employer in a business affecting interstate commerce which has one or more employees—an estimated 57 million workers in 4.1 million workplaces in the United States and its territories.

The OSH Act does *not* affect workplaces protected by other federal laws, for example the Coal Mine Health and Safety Act and the Federal Metal and Nonmetallic Mine Safety Act.

Federal employees are not covered by the Act's general enforcement procedures. However, the Act does require each federal agency to maintain a comprehensive safety and a health program.

The OSH Act does not cover state or local public employees. These groups are covered *only* by state plans where they exist.

B. ADMINISTRATION AND ENFORCEMENT

The OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA), under the U.S. Department of Labor, sets and enforces standards, prescribes regulations requiring employers to maintain and report accurate safety and health records, provides grants to help states identify safety and health needs and develop state enforcement programs.

The NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH), under the U.S. Department of Health, Education, and Welfare, conducts research, develops criteria for handling toxic substances, suggests appropriate standards to OSHA, evaluates hazards of toxic materials on employer or employee request, publishes an annual list of toxic substances, and conducts training programs for federal enforcement personnel.

The independent President-appointed OCCUPATIONAL SAFETY AND HEALTH REVIEW COMMISSION hears and rules on cases where employees or employers appeal citations.

C. EMPLOYER RIGHTS AND RESPONSIBILITIES

Generally, *employers must provide a place of employment free from recognized hazards by:*

1. Insuring the workplace conforms to applicable safety and health standards adopted under the OSH Act

2. Insuring employees have and use safe, properly maintained tools and equipment, including required protective clothing and equipment

3. Warning employees of potential hazards by color codes, posters, labels, or signs

4. Providing and paying for medical examinations required by OSHA standards

5. Recording work-related injuries and illness (for 8 or more employees) and posting a summary annually during the entire month of February

6. Reporting each injury or health hazard which causes one fatality or the hospitalization of 5 or more employees to the nearest OSHA area office

7. Not discriminating against employees for properly exercising their rights under the OSH Act

8. Posting OSHA citations for standards violations at the involved worksite

9. Posting the OSHA poster in the workplace to inform employees of their rights and responsibilities

Employers have the right to:

1. Request and receive "proper" identification of OSHA personnel before a worksite inspection

2. Participate in OSHA walkaround inspections, and the opening and closing conferences

3. Disagree with OSHA citations by filing a *Notice of Contest* with the OSHA regional office (within 15 working days of receiving the citation and notice of penalty)

4. Apply to OSHA for a temporary variance if compliance with a standard is impossible

5. Apply to OSHA for a permanent variance if able to prove that an alternative protective method is at least as effective as that required by the standard

D. EMPLOYEE RIGHTS AND RESPONSIBILITIES

Under the OSH Act, *employees are responsible for:*

1. Reading the OSHA poster at their worksites

2. Being familiar with any applicable OSHA standards

3. Reporting hazardous conditions to their supervisors

4. Reporting any job-related injuries or illnesses to their employers, and promptly seeking treatment

5. Cooperating with OSHA compliance officers conducting inspections and answering any questions about worksite conditions

Employees have the rights to:

1. Obtain information from employers on health and safety hazards in the work area, on necessary precautions, and on what to do if involved in an accident or exposed to a toxic substance

2. File written complaints with the OSHA area director requesting an inspection of workplace conditions believed hazardous

3. After filing a complaint or if designated as an employee representative, accompany OSHA compliance officers during walkaround inspections

4. Be advised of OSHA actions on complaints, and have an informal review of any OSHA decision not to inspect the workplace

5. Observe monitoring or measuring of hazardous materials, and have access to the records of these measurements

6. Request information on potentially toxic substances in the workplace from NIOSH, and have names withheld from their employers if desired

7. Be provided with protective equipment and clothing when prescribed by OSHA standards

8. File a complaint with OSHA within 30 days of being discriminated against for exercising their rights under the OSH Act

9. Challenge the reasonableness of the OSHA-set abatement period by appealing to the Occupational Safety and Health Review commission

10. Be notified by employers of any application for variance

11. Testify at variance hearings

12. Challenge any temporary or permanent variance granted by appealing to the Occupational Safety and Health Review Commission

E. REQUESTING AN OSHA INSPECTION (FILING A COMPLAINT)

Any employee may file a complaint about a job safety or health problem. Simply write a letter to the nearest OSHA area officer (see chapter's end for samples of federal OSHA complaint forms). If there's a state program, send a complaint letter or form to the state enforcement agency. If the situation is so serious that someone may be injured or killed (*imminent danger*) before you can write a letter or fill out the form, immediately telephone the nearest OSHA officer (or state enforcement agency). Then, follow up with a brief complaint letter or form. You are not expected to be an expert, so state the problem in your own words, without exaggerating. Where possible, it's also a good idea to specify whether the condition is a health or safety hazard.

It is always important to *document* your complaints in writing. Besides insuring that OSHA has a written record and will inform you of whether it decides to inspect and of the inspection results, the written complaint protects you *against employer discrimination.*

After receiving an employee's complaint, OSHA *must* either send an inspector to the workplace without warning the employer in advance, or write the employee why there will be no inspection. OSHA most commonly refuses to inspect on the grounds that either the complaint doesn't indicate sufficient reason for an inspection, or the complaint was filed for harassment purposes only. Be sure your letter or complaint form is detailed enough to justify an inspection (see Chapter 8, Documentation).

After the walkaround inspection, the inspector must have a closing conference with the employer. The employee representative can either participate in the employer's closing conference, if the employer agrees, or request a separate one. The employee representative should:

1. Ask the inspector to verbally review all the specific hazards and violations found

2. Make sure all employee complaints are noted

3. Take written notes to later inform affected employees and insure all hazards are corrected

Inspectors discovering situations that could *immediately result in serious* physical harm or death (imminent danger) *must* inform both employers and employees of the danger during the closing conferences.

Following an inspection, OSHA *must* issue a citation if the employer has violated a safety or health standard (see chapter's end for a sample OSHA citation form). OSHA may also fine employers for violating standards or for failing to correct violations within the OSHA-fixed *abatement* period. In cases of imminent danger, the OSHA office may seek a court order *immediately* closing the plant or shutting down the work process. In cases of willful violations, OSHA may seek criminal penalties against the employer.

OSHA COMPLAINT PROCEDURE

F. INSPECTIONS

OSHA compliance officers inspect workplaces on a routine basis or in response to employee complaints. Inspectors must be admitted to any workplace after showing their credentials. A management representative and an employee representative (or the employee who filed the complaint) can accompany the inspector. If there is no employee representative the inspector must interview a reasonable number of employees during the inspection. Any employee concerned about an unsafe job condition should either inform the employee representative or the inspector.

When the employer is cited or penalized, citation forms are sent to both the employer and the employee making the complaint. Citations should specify the violations and the *abatement period* (time employer has to correct the violations). An additional form listing the penalties goes to the employer. The fine's dollar amount and the abatement period's length depend upon the violation's seriousness, the difficulty of correcting it, and previous citations and penalties.

Employers must post the citation for 3 days or until the violation is corrected, whichever period is longer. If the violation is *not* corrected within the set abatement period, employees should notify OSHA (or the state program) in writing.

G. DISCRIMINATION COMPLAINTS

The OSH Act protects employees filing complaints or otherwise exercising their rights under the Act. It states:

> "*No person shall discharge or in any manner discriminate against any employee* because such employee has filed any complaint or instituted or caused to be instituted any proceeding under or relating to his rights or has testified or is about to testify in any such proceeding."

Some state programs also protect workers discriminated against for refusing to work in *imminent danger* situations.

Employees are entitled to job reinstatement with lost wages and work benefits *if*, because of formally complaining to the proper OSHA agency about unsafe working conditions or practices, they have been:

1. Discharged (fired)

2. Threatened with discharge

3. Demoted

4. Suspended

5. Discriminated against in any other manner affecting their employment

Employees claiming they have been discriminated against for exercising their rights under the Act may write a letter of complaint to the nearest OSHA area office (or appropriate state agency if there's a state plan). Complaints must be filed within 30 days of the event. A discrimination complaint should include enough information and documentation to justify the case.

Within 90 days of receiving your discrimination complaint, OSHA must:

1. Review the facts and decide whether the complaint is justified and warrants a hearing

2. Where necessary set an administrative hearing date

3. Inform the employee and employer of its decision

If OSHA decides your complaint warrants administrative hearing, be prepared to:

1. Submit a complete statement of the facts, including all relevant names and dates

2. Supplement your statement with all relevant documents, state reports, correspondence, records of phone conversations, etc. (see Chapter 8, Documentation)

3. Select your most supportive witnesses and review their testimony before the hearing

4. If possible, have a union representative or attorney present your case

5. Submit a letter from your local union president authorizing any health and safety committee persons to participate in the hearing, including yourself (it's always a good idea to have a health and safety committee person attend such hearings)

6. Have someone take notes at the hearing (such notes will be useful documentation, especially in case you request a rehearing for an unreasonable decision against you)

It is particularly helpful to document your case well, and have legal counsel, witnesses, and health and safety committee persons at the hearings.

If there is an *unreasonable decision* against you, write the OSHA hearing office requesting a rehearing. Refer to your original documented complaint and any relevant hearing notes as justification. If the response is inadequate, write a letter of complaint to the nearest OSHA office, again requesting a rehearing. If the response is still inadequate, and there's a state program, file a CASPA with the nearest federal OSHA office.

If OSHA decides in your favor and the employer refuses to comply with OSHA's recommendations, OSHA can take the case to district court. The court can reinstate the affected employees to their former positions with back pay, and restrain the employer from further discrimination.

H. STATE PLANS

If a state plan is in effect where you work, you should request inspections and file discrimination complaints with the appropriate state enforcement agency. For information on the state's enforcement procedures, contact the appropriate agency (usually the Division of Industrial Safety). As of June, 1976, the 22 states with OSHA-approved programs were:

Alaska
Arizona
California
Colorado
Connecticut
Hawaii
Indiana
Kentucky
Maryland
Michigan
Minnesota
Nevada
New Mexico
North Carolina
Oregon
South Carolina
Tennessee
Utah
Vermont
Virgin Islands
Washington
Wyoming

I. FILING A COMPLAINT AGAINST THE STATE

When, in your opinion, a state-OSHA has inadequately performed its resonsibilities, you should *promptly* notify the nearest federal OSHA office. File a written *Complaint Against State Program Administration* (CASPA) if the state agency has *not:*

1. Adequately responded to your complaint

2. Conducted a timely or adequate workplace inspection

3. Issued citations for known violations

4. Followed state-OSHA rules and regulations

5. Protected your rights against discrimination

6. Followed proper procedures for granting variances

After receiving your CASPA, the Federal OSHA office will review your complaint, then notify you in writing of its decision and of any resulting corrective action.

If dissatisfied with OSHA's response, you may request an informal conference and re-evaluation with Federal OSHA officials. Afterwards, you will be notified in writing of the final decision.

U.S. DEPARTMENT OF LABOR
OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

Form Approved
OMB No. 044R1449

For Official Use Only		
Area	Date Received	Time
Region	Received By	

OSHA-7

COMPLAINT

This form is provided for the assistance of any complainant and is not intended to constitute the exclusive means by which a complaint may be registered with the U.S. Department of Labor.

The undersigned *(check one)*

☐ Employee ☐ Representative of employees ☐ Other *(specify)* ______

believes that a violation at the following place of employment of an occupational safety or health standard exists which is a job safety or health hazard.

Does this hazard(s) immediately threaten death or serious physical harm? ☐ Yes ☐ No

Employer's Name ______

Address (Street ______ Telephone ______
(City ______ State ______ Zip Code ______

1. Kind of business ______
2. Specify the particular building or worksite where the alleged violation is located, including address. ______
3. Specify the name and phone number of employer's agent(s) in charge.
4. Describe briefly the hazard which exists there including the approximate number of employees exposed to or threatened by such hazard.

(Continue on reverse side if necessary)

Sec. 8(f)(1) of the Williams-Steiger Occupational Safety and Health Act, 29 U.S.C. 651, provides as follows: Any employees or representative of employees who believe that a violation of a safety or health standard exists that threatens physical harm, or that an imminent danger exists, may request an inspection by giving notice to the Secretary or his authorized representative of such violation or danger. Any such notice shall be reduced to writing, shall set forth with reasonable particularity the grounds for the notice, and shall be signed by the employees or representative of employees, and a copy shall be provided the employer or his agent no later than at the time of inspection, except that, upon request of the person giving such notice, his name and the names of individual employees referred to therein shall not appear in such copy or on any record published, released, or made available pursuant to subsection (g) of this section. If upon receipt of such notification the Secretary determines there are reasonable grounds to believe that such violation or danger exists, he shall make a special inspection in accordance with the provisions of this section as soon as practicable, to determine if such violation or danger exists. If the Secretary determines there are no reasonable grounds to believe that a violation or danger exists he shall notify the employees or representative of the employees in writing of such determination.

COMPLAINT ABOUT STATE 18(B) PROGRAM ADMINISTRATION

1. This form is provided to assist you in the filing of your complaint about the administration of the State's Occupational Safety and Health Program. Your complaint, however, must be based on facts directly related to the following:

   1. Action(s) which took place at a specific time and place.
   2. Action(s) which you believe indicate inadequate administration of the State's Occupational Safety and Health Program.

2. Date of Incident	3. State	4. County	5. City

6.Street Address Where Incident Occurred

7. Name of Employer or Name of Place Where Incident Occurred, If Applicable

8. Name(s) and Occupation(s) of Persons Involved in Incident, If Applicable

9. Describe the Incident which caused your complaint.

10. Name(s) of Person(s) Submitting Complaint (will be withheld upon request)

11. Telephone where you can be reached for information Area Code: No. Ext.	12. Date This Form Completed

13. Address No., Street, City and State, Zip Code

14. [ ] Do not Reveal My Name [ ] You May Reveal My Name During Investigation

15. The State Agency [ ] Has [ ] Has not been Furnished this Data

16. Signature of Person Filing Report

For complaints against the States of Arizona, California, Nevada, Hawaii, Guam, Samoa or Trust Territories, mail this form to: U.S. Department of Labor, 450 Golden Gate Avenue, Box 36017, OSHA, San Francisco, California 94102.

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DOCUMENTATION

Keeping well-documented health and safety-related personal records is important. The information is invaluable if you later file letters of complaint to OSHA, discrimination complaints, worker's compensation claims, grievance proceedings, etc. In addition, the resulting individual exposure histories can help unions and scientific personnel identify workplace accident and illness trends.

A. PERSONAL HEALTH AND SAFETY RECORDS

The information included in workers' personal health and safety records alerts them to their personal physical conditions and possible job-related health problems. Personal records should include information about pre-employment and periodic medical examinations, safety and health training, work-related injuries and illnesses, and workplace monitoring. In addition, employees should keep records of communications with union, management, and government personnel.

1. PRE-EMPLOYMENT PHYSICALS

Request your examination results be sent to your private physicians. Or, if that's impossible, be sure you are given an explanation of the results. Your records should include:

1. Date of pre-employment physical
2. Job, including job description or conditions
3. Names, addresses, and specialties of persons and agencies conducting the physical examination
4. X-ray and laboratory tests—blood, urine, blood pressure, etc.—and results

2. PERIODIC MEDICAL EXAMINATIONS

Some OSHA standards such as asbestos require the employer to provide exposed workers with periodic medical examinations. As with pre-employment physicals, workers should have the results sent to their personal physicians or receive an explanation of the results. In addition to the items listed above for pre-employment physicals, records of periodic exams should include:

1. Comparisons to previous tests to determine whether any significant changes have occurred
2. Any attempts by management to inform the worker about medical problems and provide necessary follow-up exams and treatment

3. SAFETY AND HEALTH TRAINING

Employees should document any training they receive. Records should include:

1. Type of training provided at hiring

2. Specific protective equipment and clothing provided, training in how to use them, work assignment, and associated hazards

3. Any health and safety training provided when new work assignments were made, a description of the new work assignments, and any safety equipment or clothing provided

4. Types of continuous training provided—books, pamphlets, films, posters, instruction, on-the-job, and whether both health and safety are included

5. Duration of training

4. WORK-RELATED ILLNESSES AND INJURIES

Workers should report in writing to the employer every personal work-related accident or illness, no matter how minor. They should also notify their union representatives in writing of the injury or illness, where it occurred, and whether other workers have reported similar accidents or illnesses for the same work process or location. At that point, workers should also discuss with their union representatives whether to file a worker's compensation claim.

Records should include:

1. Type of injury or illness

2. Duration

3. Lost worktime or workdays

4. Diagnosis and treatment prescribed

5. Names, addresses, and specialties of persons responsible for diagnosis and treatment (also relationship to employer)

6. Similar job-related injuries or illnesses sustained by fellow workers at same work process or location

7. Copies of all communications sent to management and union related to the injury or illness

5. WORKPLACE MONITORING

Workers have the right to observe and be informed of all monitoring results involving their specific work areas or related to areas with which they have direct contact. Records should include:

1. Hazard

2. Frequency and type of monitoring

3. Names of individuals conducting monitoring tests

4. Dates monitoring results were recorded, and where monitoring was conducted

5. Any efforts by management to lower exposure levels exceeding legal limits

6. COMMUNICATIONS WITH UNION, MANAGEMENT, AND GOVERNMENT PERSONNEL

Individual workers usually find it impossible to correct the numerous and recurring health and safety hazards encountered on the job, or to consistently follow up on any improvements made. Unions can do that. To help their unions document problems, each individual should keep a notebook or log specifically devoted to health and safety communications, with separate sections for union, management, and government personnel.

In each section:

1. Record in chronological order and keep copies of all written requests, inquiries, and responses sent and received

2. Record and briefly describe all relevant telephone and personal conversations with management and first-line supervisors on health and safety issues

3. Keep all relevant materials and information received as a result of such communications

B. FILING COMPLAINTS (INSPECTION REQUESTS)

Complaints should adequately identify the hazard, its location, the standards violated (if known), and sufficient background and supporting information to justify the complaint. In addition, during an inspection be prepared to inform the inspector of any efforts you or your representative have made to resolve the problem—communications with management, union, or government personnel. (Your personal Health and Safety Records should include such information).

Complaints should indicate:

1. The problem and, if there's a state program, whether it is a health or safety hazard

2. Whether you or other workers are in immediate danger (*imminent danger*)

3. The hazard's location—building, area, specific machine, work process, shift, etc.

4. Names, addresses, and telephone numbers of management representatives previously contacted about the problem

5. Date and content of any oral or written communications with management, government, or union personnel (with copies attached)

6. The specific jobs or work processes performed by you and other potentially affected workers, and how these relate to the hazard

7. Whether you or others have been made ill or injured as a result of exposure, and whether worker's compensation claims were filed

8. Whether the problem has occurred in the past, and whether a citation or penalty was ever issued

9. Whether you have raised this issue with union representatives for possible grievance action

Always keep a copy of the complaint in your personal records. In addition, send a copy to union representatives if not yet notified of your complaint. Keep a record of names, dates, and content of any conservations with union and management personnel prior to inspection.

C. FILING DISCRIMINATION COMPLAINTS

The OSH Act protects workers against employer discrimination for exercising their rights under the Act. Keep records of all management actions possibly related to any complaint about workplace hazards. Your records should include:

1. Copies of job evaluations (to later demonstrate your work performance has never been criticized)

2. Absences and illnesses (to later demonstrate you have not abused sick leave provisions)

3. Management responses to your complaints about health and safety hazards (especially if management representatives seem hostile or threatening)

4. Whether your relationship with management deteriorated following complaints about health and safety hazards (document how—letters of reprimand from your personnel file, denied promotion or merit increases, general harassment, termination, layoff, etc.)

5. Names of workers and union representatives told about your health and safety complaints and about management's responses (they may later serve as witnesses at a discrimination complaint hearing)

6. Copies of all conversations and communications with management subsequent to filing a discrimination complaint (also send copies to union representatives)

D. FILING WORKER'S COMPENSATION CLAIMS

Most states have labor laws requiring employers to protect employees sustaining job-related injuries or illnesses by carrying worker's compensation insurance or by self-insurance certification.

Workers should promptly report job-related injuries or illnesses to management and union representatives. Employers should refer them for necessary medical care and immediately report the claim to the insurance carrier.

In some states, the employer's insurance pays the injured worker's necessary medical care, temporary disability benefits at 2/3 of lost wages, and long-term benefits for permanent disability. The employer or employer's insurance carrier may also pay for the vocational rehabilitation of qualifying disabled workers.

Workers believing they have not received sufficient benefits to compensate them for injury or illness should file a claim with the state worker's compensation program. Although many claims are not disputed by employers, workers should be prepared to provide background and supporting information justifying their claims.

If you file a worker's compensation claim, be prepared to:

1. Explain your specific occupation, the duties involved, and the skills required (this information will help determine your compensation rate)

2. Present your records of your annual earnings (W-2 forms) for at least the previous 3 years and any additional work-related, employer-paid expenses such as meals, travel, per diem, overtime, etc. (additional earnings might increase the hourly pay rate computed for your claim)

3. If you are a new or recent employee, produce evidence that you would have continued working, and that there were no indications of possible termination or layoff (your union business agent may attest to the work's projected availability)

4. Explain the date and nature of the injury or illness, and how it occurred

5. Present evidence from your personal health and safety records of all previous job-related injuries and illnesses, and previous worker's compensation claims (previous injuries or illnesses contributing to your present disability may increase your claim)

6. Present copies of information in your personnel file, especially reports about good work habits or previous injuries or illnesses

7. Indicate whether another party's negligence caused or contributed to your injury or illness (if so, a third-party or malpractice suit may be possible in addition to a worker's compensation claim)

8. Present a record of all employer-made payments related to your illness or injury—employers may be additionally penalized for unreasonable delay in furnishing such benefits as

   1) prescription and medical bills

   2) mileage to and from physicians' offices, drug stores, etc.

   3) temporary and permanent disability payments based on the correct rate

9. Present evidence of any injuries and illnesses sustained since you have returned to work, including

   1) how long you were off the job

   2) how many days you were unpaid

   3) the date you returned to work

   4) whether you were penalized when you returned to work

10. Explain your claim's main objective(s) to help your advisors determine the most effective method to pursue your case

   1) medical treatment

   2) financial compensation

   3) vocational rehabilitation

You may want union or legal representatives to present your case. If so, go over the above information with them before the hearing.

APPENDIX A
WORKPLACE STANDARDS

OSHA and state health and safety standards were adopted from 3 existing sources:

1. Existing federal or state standards

2. National Concensus Standards from the American National Standards Institute (ANSI) and others

3. Proprietary Standards from such sources as Underwriters Laboratories or the American Conference of Governmental Industrial Hygienists.

Standards-setting procedures were established by the 1970 OSH Act and subsequent state acts so new standards can be promulgated at federal and state levels as the need arises or as more information becomes available (particularly for air contaminants).

Standards applicable to foundry work are found throughout the Federal Register. The following are some examples.

SOME FEDERAL STANDARDS APPLICABLE TO FOUNDRIES

	Section in Federal Register
Ventilation:	1910:94
abrasive blasting	
grinding	
spray finishing operations	
spray cleaning and degreasing	
Occupational Noise Exposure	1910:95
Ionizing Radiation	1910:96
Compressed Gases (General Requirements)	1910:101
Personal Protective Equipment (general)	1910:132
eye and face	1910:133
respiratory	1910:134
head	1910:135
foot	1910:136
Signs and Tags for Accident Prevention (warning signs)	1910:145
Medical Services and First Aid	1910:151

Fire Protection and Suppression	1910:156-163
Inspection of Compressed Gas Cylinders	1910:166
Materials' Handling (general)	1910:176
powered industrial trucks	1910:178
overhead and gantry cranes	1910:179
Machinery and Machine Guarding	
definitions	1910:211
general requirements	1910:212
woodworking machinery	1910:213
abrasive wheel machinery	1910:215
mechanical power transmission apparatus	1910:219
Hand and Portable Powered Tools	
definitions	1910:241
general	1910:242
guarding	1910:243
Welding, Cutting, and Brazing	All of Section Q
National Electrical Code	1910:309
Walking-Working Surfaces	
definitions	1910:21
general requirements	1910:22
guarding floor and wall openings and holes	1910:23
fixed industrial stairs	1910:24
portable wooden ladders	1910:25
portable metal ladders	1910:26
fixed ladders	1910:27
Means of Egress (Exits)	All of Subpart E
Air Contaminants	1910:93

see Appendix for explanation of terms used in air contaminant standards.

Safety standards are for the most part straightforward and easily understood. For example:

"Belt sanders shall have both pulleys and the unused run of the sanding belt enclosed."

"Portable circular saws having a blade diameter over two inches shall be equipped with guards or hoods which will automatically adjust themselves to the work when the saw is in use, so that none of the teeth are exposed to contact above the work."

Health standards require some explanation. Most are for air contaminants since most substances enter the body through the respiratory system. Some, such as benzene, which can also enter the body through the skin, have a lower exposure limit than they would if only inhaled. Standards for skin-absorbing substances are marked with an (s).

Air contaminant standards are mostly in numbers—the concentration (amount of a substance per amount of air) of a particular substance to which a worker can be exposed (exposure limit). Exposure limits are usually given in units of ppm or Mg/M^3, or both.

ppm	parts of the substance per million parts of air (1 ppm is equivalent to 1/15 inch per mile)
mg/M^3	number of milligrams of a substance in a cubic meter of air (a cubic meter is approximately a cubic yard)

Dust exposures may also be in mppcf (millions of particles per cubic foot)

Generally, exposure limits (see sample) are for 8-hour time-weighted averages. An 8-hour average exposure can be determined either by taking a full 8-hour sample or by measuring the amount of a substance to which a person is exposed at various times during an 8-hour day and averaging these exposures. A "C" alongside the exposure limit number indicates the exposure limit listed is a ceiling value. *No* exposure above a substance's *ceiling value* is allowed even if the 8-hour exposure averages to less than the listed standard.

PROBLEMS WITH AIR CONTAMINANT STANDARDS

Standards are not fine distinctions between safe and dangerous concentrations. They are only guides to controlling health hazards. Exposures producing serious problems in one person may affect others far less. Standards, usually based on the *best currently available evidence,* may not adequately protect exposed workers. Research may have been insufficient or crucial information on a substance's toxicity may not have been established. This is particularly a problem for substances producing slow-developing diseases such as cancer or silicosis. In addition, standards do not usually protect workers against interaction (synergism) of several substances together. Some substances can have far more hazardous effects in combination than either has alone. Finally, little is known about the hazards of most chemicals used in the workplace. There are standards for only slightly more than 500 substances.

APPENDIX B

GLOSSARY OF FOUNDRY TERMS

BINDER	a material such as clay, flour, molasses, linseed oil, or resin, used to hold core or molding sand together
CASTING	a metal shape obtained as a result of pouring molten metal into a mold
CORE	a shaped mass of sand placed in a mold to create holes and various shaped cavities in a casting
CORE BOX	a wooden or metal mold in which a core is formed
CORE BLOWER	a machine that uses compressed air to blow sand into a core box
CORE OVEN	a brick or asbestos-lined oven for baking cores
CRUCIBLE FURNACE	a refractory-lined furnace, heated by coal, coke, gas, or oil, for melting small amounts of metal in large pots (crucibles)
CUPOLA	a vertical refractory-lined furnace for melting iron and other metals in contact with coke. Metal, coke, and flux are charged into the furnace in alternate layers. Molten metal is tapped off through one spout, and slag through another
DRAG	the bottom part of a flask or mold
DRAWING	removing the pattern from the sand
DRYING CRADLE	a metal frame or rack in which ladles are placed while their linings are dried or heated
ELECTRIC ARC FURNACE	a metal-melting furnace in which the heat is generated by an electric arc passing between electrodes and the metal
FLASK	a metal or wooden frame, without top or bottom, in which a mold is formed
FLUX	substance added to a furnace that combines with metallic and nonmetallic impurities to carry them off in the slag

GATE	a channel through which molten metal enters a casting cavity
GREEN SAND	molding sand mixed with water, used in molds and cores
GREEN-SAND CORE	a core made of green sand and not baked
HAND RAMMER	a tool used to tightly pack sand into molds by tamping
LADLE	a vessel used to transport and pour molten metal
MIXING BOX	a shallow box in which sand, clay, and water are mixed
MOLD	a mass of molding sand or other heat-resistant material containing a cavity which forms a casting when filled with molten metal
MOLDING SAND	a mixture of sand and binding material used to make molds—it bonds strongly, resists melting from contact with molten metal, and allows gases to escape
MONORAIL CRANE	a cable and pulley system suspended from wheels running on an overhead track, and used to lift and transport heavy loads
PARTING LINE	joint where a mold separates to allow removal of the pattern
PARTING SAND	a sand dusted on the parting to prevent mold parts from sticking to each other
POURING	filling a mold with molten metal
RAMMING	the process of packing sand in a mold or core box with a rammer or rod
REFRACTORY MATERIAL	material used to line cupolas, ladles, etc., which is highly resistant to high temperatures (for example, bricks, refractory cement)
RISER	a column of metal placed in the mold to feed the casting as it solidifies and shrinks
ROLL-OVER MACHINE	a machine which turns a mold over after the sand has been packed so the pattern may be removed. A jolting mechanism may be used with this machine to pack the sand
SAND MULLER OR MIXER	a machine that mixes sand, water, and binders to be used in molds or cores

SAND SLINGER	a machine, either moveable or stationary, that forcefully throws sand into flasks to produce an evenly packed mold
SLAG	impurities which rise to the top of molten metal
SPRUE	the opening in a mold into which the metal is first poured
SQUEEZE MOLDING MACHINE	a machine equipped with a pressure head used to pack the sand into a mold by compression
STEEL SHOT	hard iron or steel pellets used in blasting operations as a substitute for the traditional sand blasting
TILTING FURNACE	a furnace balanced so that it can be tipped to pour out the molten metal
TUMBLER	a machine in which casting are cleaned by tumbling them with some type of abrasive material to remove sand and scale
VENT	a small opening in a mold which facilitiates the escape of air and gases

GLOSSARY OF MEDICAL TERMS

ACUTE	(short-term), taking a short time to produce an effect or disease
ANEMIA	any condition in which the number of red blood cells, the amount of hemoglobin, or the volume of packed red blood cells per 100 milliliters of blood is less than normal
ASTHMA	an allergic reaction of the lungs—the air passages close down, making breathing difficult
BRONCHITIS	infection of the air tubes (bronchi) causing increased mucous (phlegm) production and reducing breathing capacity
CANCER	abnormal and rapid growth of cells, which may start in one part of the body and spread
CHRONIC	(long-term), taking a long time to cause a disease
DERMATITIS	redness, cracking, itching, swelling of the skin
HEMOGLOBIN	oxygen-carrying part of the blood
IRRITANT	having an effect on outer layer of skin, mouth, lungs, throat, etc., which may cause burning, chapping, drying, or swelling
LOCAL	a chemical's effect which takes place at the point of contact
METAL FUME FEVER	an acute disease with flu-like symptoms, caused by exposure to fumes from metals such as zinc and magnesium—symptoms can last 24 to 72 hours without apparent long-term effect (usually, only workers new to a process or who have been away from it for awhile develop symptoms)
NARCOTIC	having an effect on the central nervous system, especially the brain, with such symptoms as giddiness, dizziness, headache, confusion, and in some cases, possibly coma or death
PULMONARY EDEMA	the lungs become so irritated they fill with fluid (similar to a burn blister)
RESPIRABLE	particles of dusts, fumes, etc., small enough to get into the lungs

SENSITIZATION — an allergic condition (sensitivity reaction) that usually affects either the skin (dermatiti) or the lungs (asthma)—once exposure to a substance has cause a reaction, the individual is *sensitized,* and any further exposure will cause a reaction

SYNERGISM — the combined action of two or more chemical substances

SYSTEMIC — a chemical's effect on the body which is someplace other than the point of contact

TOXIC — hazardous to a particular organ or system—silica for example is toxic to the lungs

APPENDIX C
WORKER'S COMPENSATION*

All states have worker's compensation laws in one form or another. The California law was passed early in the 20th Century to benefit workers with job-related injuries or illnesses. The California law:

1. Insures that employees with *industrial injuries* have adequate support for themselves and their dependents while unable to work

2. Provides a means to settle disputed claims as quickly as possible.

Before the California Worker's Compensation law was passed, workers injured on the job could only recover lost wages and medical expenses by suing their employers in court. The process was costly, time consuming, and unfair. Workers rarely received any compensation. The current law replaces court jurisdiction with an automatic, no-fault insurance program. Though it insures that *any* worker can be compensated, it also limits the employer's financial responsibility.

Under the California Worker's Compensation system, a compensable *industrial injury* may be defined as:

1. SPECIFIC INJURIES OR DISEASES caused by specific incidences or exposures

2. CUMULATIVE INJURIES resulting from the combined effect of recurring physical or mental trauma

3. OCCUPATIONAL DISEASES occurring from exposures over a period of time to hazardous substances or physical agents in the work environment

4. WORK-AGGRAVATED, PRE-EXISTING CONDITIONS: conditions such as heart disease and arthritis *if* worsened and made disabling by work-related incidences or conditions

5. DAMAGE to dentures, artificial limbs, hearing aids, eye glasses, medical braces, etc. *if* caused by work-related incidences or conditions

In addition to the more easily recognizable injuries and illnesses such as dermatitis, back injuries, broken bones, and so on, other *industrial injuries* that may be compensable include: heart disease; metal fume fever (with flu-like symptoms); emphysema; cancer; tuberculosis; silicosis; arthritis; nervousness; high blood pressure; mental breakdown; suicide; berylliosis; neuritis; pneumonia; asthma; kidney and liver damage; etc.

*This material was not prepared under OSHA contract #J-9-F-6-0017.

A. WHEN IS AN INJURY WORK RELATED?

To be compensable, work-related injuries must *arise out of* or *in the course of* employment. To *arise out of employment*, the injury must occur while the employee is performing a work-related service or function. However, the employment doesn't have to the sole cause of injury. Workers may be eligible if the employment is only a contributing factor. In such case, the injury is *proximately* caused. To be *in the course of employment*, the injury must occur while the employee is:

1. Going to or from work

2. Travelling for the employer

3. Going to the restroom, engaging in recreational activities during breaks, or doing other acts of personal comfort or convenience during work hours

4. In the workplace parking lot

5. Leaving the work premises or going to work

Any *reasonable doubt* that the injury is work related *must be decided in the employee's favor.*

REMEMBER—the key issue is whether the injury or illness is caused by your job.

B. WHO IS COVERED?

Worker's compensation protects most California workers, including minors, apprentices, and public employees. The law does *not* cover:

1. Casual employees earning less than $100 in 10 days or less

2. Household domestic employees working less than 52 hours per week

3. Prison laborers

4. Newspaper minors purchasing the papers they sell

5. Volunteer workers

6. Welfare workers working for charitable organizations in exchange for room and board

7. Part-time gardeners working less than 44 hours per month per customer

8. Subscription watchmen paid by several nonindustrial establishments

9. Athletic sponsors

10. Nonsalaried partners in a business, worker-partners, or employee-partners

11. Independent contractors

12. Employees with their own worker's compensation laws, such as federal employees and employees involved in interstate commerce—longshore and harbor workers, seamen, railway employees

C. WHAT ARE THE BENEFITS?

California law guarantees workers 3 kinds of benefits—medical care, rehabilitation, and lost wages.

1. MEDICAL CARE TO CURE THE INJURY OR ILLNESS

The employer's insurance company pays all medical costs directly to service providers. Benefits include:

1. Doctor bills

2. Drug prescriptions

3. Hospital costs

4. Laboratory and x-ray test fees

5. Costs of crutches, wheelchairs, etc.

6. Costs of travelling to and from injury-related services—doctor, pharmacy, physical therapist, etc.

2. REHABILITATION SERVICES NECESSARY FOR WORKER'S RECOVERY AND RETURN TO WORK

The employer or his insurance company pays all rehabilitation service costs directly to service providers. Sometimes rehabilitation is an extension of medical treatment, for example physical therapy to strengthen muscles. Disabled workers may also qualify for vocational rehabilitation and retraining if prevented from returning to their usual jobs by the injury.

3. CASH PAYMENTS FOR LOST WAGES

The most usual type of payment is TEMPORARY DISABILITY, made as long as you haven't reached maximum eligibility and your doctor says you are unable to work. Additional cash payments will be made after you are able to return to work for any PERMANENT DISABILITY such as amputated fingers or loss of sight or hearing. If the injury or illness causes death, payments will be made to surviving dependents.

TEMPORARY DISABILITY PAYMENTS help injured workers meet daily expenses while recovering from an injury or until further improvement is not expected. At this point, temporary disability payments stop. Employees who are still unable to return to work or permanently disabled may be entitled to PERMANENT DISABILITY PAYMENTS. If injured workers are hospitalized, temporary disability payments start immediately. If they are not hospitalized, payments are delayed for 3 days. Nonhospitalized workers will be paid for the 3-day wait if their disability lasts more than 21 days. Under no circumstances can temporary disability payments be made for more than 240 weeks during the 5 years following the date of injury.

PERMANENT DISABILITY PAYMENTS are begun when the injury's effects became *stationary.* That is, a decision is made that the injury is not going to get any better or worse. At this point, the disability is rated to determine the amount of money to be received for permanent loss of working ability. The *percent of permanent disability* determines the number of payment weeks. Unless you are *totally disabled,* payments can last no more than 621¼ weeks (approximately 9 years).

D. HOW ARE DISABILITY CASH PAYMENTS MADE?

1. TEMPORARY BENEFITS

For injuries occuring on or after April 1, 1974, the minimum temporary disability rate is $35 per week, the maximum $119 per week. The award is ⅔ the injured worker's *average* weekly wage at the time of injury, as long as the average is no more than $178.50 per week. Those earning more are still entitled to only $119 per week.

Temporary disability payments are made at least twice a month. They are exempt from:

1. State and federal taxes
2. Social security taxes
3. Union or retirement fund contributions
4. Attachment (*garnishment*) by creditors.

2. PERMANENT BENEFITS

Permanent disability benefits are determined from: the worker's earning capacity, age, and occupation at the time of injury; the kind of injury; and the percent of disability. The minimum award is $20 per week. The maximum is $70 per week unless the injury or illness is totally disabling (at least 70 percent) and occurred on or after April 1, 1974. In that case, permanent disability payments are based on the temporary disability rate, and payable for life.

Dependents of workers killed by job-related injuries or illnesses are entitled to $40,000 maximum if the death occurred on or after January 1, 1975. The only exception is for a surviving widow with one or more dependent minor children. Then, the maximum benefit is $45,000. There is also a $1,000 maximum burial expense.

E. WHEN SHOULD YOU FILE FOR BENEFITS?

File for Worker's Compensation *as soon* as you sustain any industrial injury or disease or think you have injury or disease. There are *time limits* for filing your claim:

1. One year from date of injury (for specific injuries and illnesses),

or

2. One year from date the insurance company last furnished benefits,

or

3. One year from date worker knew or should have known the disability was work-related (for cumulative injuries or occupational diseases),

or

4. One year from date of becoming disabled (*for cumulative injuries or occupational diseases*)

F. WHAT SHOULD YOU DO WHEN AN INJURY OCCURS?

If your workplace has a first-aid facility, get immediate treatment, and report where, when, and how the accident occured. In an emergency, immediately get the best treatment available. Report the injury to your employer as soon as you can.

If additional treatment is necessary, your employer or supervisor must make arrangements for medical care. You may be sent to a "company doctor." You can also go to your own doctor, but only at your expense unless the company agrees. If you don't like the company doctor, you may request a change of doctors *once.* However, you must choose from a list of 5 doctors provided by the employer's insurance carrier.

1. WHAT HAPPENS IF YOU ARE DISSATISFIED WITH ALL COMPANY DOCTORS

You can choose your own doctor *30 days* after reporting the injury. Choose wisely, and get advice on specialists from union representatives or individuals whose opinion you respect. Report your choice to your employer as soon as you decide so your bill will be paid promptly.

2. WHAT HAPPENS IF YOU ARE DISSATISFIED WITH BENEFITS RECEIVED?

If you think you have not received all benefits due, contact your union representative, employer, and employer's insurance carrier. If still dissatisfied, get advice from the nearest State Division of Industrial Safety (DIS) office. It may be necessary to file an APPLICATION FOR ADJUDICATION OF CLAIM with the WORKER'S COMPENSATION APPEALS BOARD (see chapter's end for sample Application).

The Appeals Board is an administrative court of law. You can represent yourself, but you may prefer to have a union representative or attorney handle the case. The attorney's fee will range between 10 and 15 percent of the final award, and be deducted from it. If going to the Appeals Board is necessary, be sure to do it *within one year* of either the date of injury or your last medical treatment. Waiting any longer could mean losing your right to additional benefits.

Sometimes the parties to a disputed claim may want to settle on a sum out of court. Any such *Compromise and Release* must be approved by the Appeals Board. *Approval ends the employee's claim and releases the employer from further legal responsibility.* Additional proceedings will be allowed only in rare instances.

STATE OF CALIFORNIA
AGRICULTURE AND SERVICES AGENCY
DEPARTMENT OF INDUSTRIAL RELATIONS

SEE REVERSE SIDE FOR INSTRUCTIONS

DIVISION OF INDUSTRIAL ACCIDENTS—WORKERS' COMPENSATION APPEALS BOARD

APPLICATION FOR ADJUDICATION OF CLAIM CASE No.

Mr. Mrs. Miss ____________________ (INJURED EMPLOYEE) ____________________ (INJURED EMPLOYEE'S ADDRESS)

Social Security No. ____________________ ____________________

____________________ (APPLICANT, IF OTHER THAN INJURED EMPLOYEE) ____________________ (APPLICANT'S ADDRESS AND ZIP CODE)

vs. ____________________

____________________ (EMPLOYER) ____________________ (APPLICANT'S TELEPHONE NUMBER)

____________________ (EMPLOYER'S ADDRESS) ____________________

____________________ (EMPLOYER'S INSURANCE CARRIER OR STATE IF SELF-INSURED OR PERMISSIBLY UNINSURED) ____________________ (ADDRESS OF INSURANCE CARRIER, IF ANY)

IT IS CLAIMED THAT:

1. The injured employee, born ________ (DATE OF BIRTH), while employed as a ________ (OCCUPATION AT TIME OF INJURY) on ________ (DATE OF INJURY) at ________ (CITY), ________ (STATE), by the employer sustained injury arising out of and in the course of employment to ________ (STATE WHAT PARTS OF BODY WERE INJURED)
2. The injury occurred as follows: ________ (EXPLAIN WHAT EMPLOYEE WAS DOING AT TIME OF INJURY AND HOW INJURY WAS RECEIVED)
3. Actual earnings at time of injury were: ________ (GIVE WEEKLY OR MONTHLY SALARY OR HOURLY RATE AND NUMBER OF HOURS WORKED PER WEEK)
________ (SEPARATELY STATE VALUE PER WEEK OR MONTH OF TIPS, MEALS, LODGING OR OTHER ADVANTAGES REGULARLY RECEIVED)
4. The injury caused disability as follows: ________ (SPECIFY LAST DAY OFF WORK DUE TO THIS INJURY AND BEGINNING AND ENDING DATES OF ALL PERIODS OFF DUE TO THIS INJURY)
5. Compensation was paid ____ (YES) ____ (NO) $________ (TOTAL PAID) $________ (WEEKLY RATE) ________ (DATE OF LAST PAYMENT)
6. Medical treatment was received ____ (YES) ____ (NO) ________ (DATE OF LAST TREATMENT) All treatment was furnished by the employer or insurance company ____ (YES) ____ (NO) other treatment was provided or paid for by ________ (NAME PERSON OR AGENCY PROVIDING OR PAYING FOR MEDICAL CARE)
Doctors not provided or paid for by employer or insurance company, who treated or examined for this injury are
________ (STATE NAMES AND ADDRESSES OF SUCH DOCTORS AND NAMES OF HOSPITALS TO WHICH SUCH DOCTORS ADMITTED INJURED)
7. Unemployment Insurance or Unemployment Compensation Disability benefits have been received since the date of injury ____ (YES) ____ (NO)
8. Other cases have been filed for industrial injuries by this employee as follows: ________ (SPECIFY CASE NUMBER AND CITY WHERE FILED)
9. This application is filed because of a disagreement regarding liability for: Temporary disability indemnity____ Permanent disability indemnity____ Reimbursement for medical expense____ Medical treatment____ Compensation at proper rate____ Other____ Specify: ________
and applicant requests a hearing and award of the same, and for all other appropriate benefits provided by law.

Dated at ________ (CITY), California, ________ (DATE)

____________________ (APPLICANT'S ATTORNEY) ____________________ (APPLICANT'S SIGNATURE)

____________________ (ADDRESS AND TELEPHONE NUMBER OF ATTORNEY)

Please file signed original and six copies and print or type names and addresses

DIA WCAB FORM 1 (REV. 4-75)