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Ulah Battery Health and Safety Plan

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TABLE OF CONTENTS

- 1.0 Health Hazards
 - 1.1 Compounds of Concern
 - 1.1.1 Lead Toxicity
 - 1.1.2 Sulfuric Acid Toxicity
 - 1.2 Routes of Entry
- 2.0 Occupational Health Standards
- 3.0 Air Monitoring
 - 3.1 Purpose
 - 3.2 Methods and Procedures
- 4.0 Medical Surveillance
 - 4.1 Purpose
 - 4.2 Blood Lead
 - 4.3 Medical Removal
- 5.0 Site Safety
 - 5.1 General Safety Rules
 - 5.2 Site Work Areas
- 6.0 Protective Equipment
 - 6.1 Introduction
 - 6.2 Personal Protective Equipment
 - 6.3 Respiratory Protection
 - 6.4 Heat Stress
- 7.0 Decontamination
 - 7.1 Introduction
 - 7.2 Personal Protective Equipment
 - 7.3 Equipment Decontamination
- 8.0 Training
- 9.0 Site Security
- 10.0 Fire Safety Procedures
- 11.0 Preparedness, Contingency and Emergency Plan
 - 11.1 Introduction
 - 11.2 Specific Response
 - 11.2.1 Injury
 - 11.2.2 Fire
 - 11.2.3 Spills/Releases
 - 11.2.4 Off-Site Incidents

- Appendix A: Emergency Phone Numbers and Directions to Hospital
- Appendix B: Heat Stress
- Appendix C: The OSHA Lead Standard (29 CFR 1910.1025)
- Appendix D: North Carolina Heat Stress Position Paper

1.0 HEALTH HAZARDS OF LEAD

1.1 COMPOUNDS OF CONCERN

Lead present in storage batteries consists of inorganic oxides of lead (lead monoxide and lead tetroxide). Lead-acid storage batteries contain inorganic lead and potentially low concentrations of other heavy metals. Storage batteries also contain sulfuric acid. The sulfuric acid in the batteries has been drained. The compounds of concern to health at the work site are inorganic lead, and sulfuric acid. Due to the potential low concentrations of heavy metal other than lead, these substances are not expected to result in significant amounts. Because of the extended period of time that the sulfuric acid has been at the site, it is not anticipated that sulfuric acid will be present in the concentrated form, or present a significant health hazard.

1.1.1. LEAD TOXICITY

Lead is toxic if it enters the body and accumulates in significant amounts. There are no early warning signs for lead ingestion or inhalation. Lead that is absorbed into the body is transported to various organs and tissues where injury may occur. Lead in blood is held by the red blood cells, however lead has a preference for the bones and accumulates in bone tissue. Lead poisoning results in adverse affects to the nervous system resulting in impaired nervous system functioning. Lead adversely affects the blood and blood forming (bone marrow) tissue. One of the results of lead's action on the blood is anemia. Lead may also cause injury to the kidneys, and reproductive system. Symptoms of overexposure include loss of appetite, metallic taste in the mouth, constipation, nausea, insomnia, headache, numbness, dizziness, and joint pain or soreness.

1.1.2 SULFURIC ACID TOXICITY

Concentrated sulfuric acid can cause burns to the skin due to a strong exothermic (heat generating) reaction with water. Sulfuric acid is rapidly injurious to mucous membranes and dangerous to the eyes. Sulfuric acid is a dehydrating agent and removes water from organic materials causing charring. Inhalation of sulfuric acid causes a burning feeling in the throat, cough, and a burning sensation in the eyes. Sulfuric acid mist can cause injury to the teeth. The irritating effects of sulfuric acid provides an early warning of exposure.

1.2 ROUTES OF ENTRY

The routes of entry into the body for lead is by inhalation or ingestion. The main route of entry is inhalation. Ingestion of lead can occur from hand-to-mouth by unwashed hands when handling food, or by inhalation of lead contaminated dusts which

may enter the upper respiratory tract and may be swallowed after a coughing reflex. Lead can also be ingested by any hand-to-mouth action, such as cigarette smoking. The ingestion route of entry can considerably increase total exposure. Inorganic lead does not penetrate the skin and skin absorption does not occur.

Sulfuric acid primarily presents a potential skin contact hazard. During the excavation of contaminated soils, sulfuric acid may become an aerosol and become airborne resulting in a hazard to the mucous membranes and upper respiratory tract. Although sulfuric acid is not anticipated to be present to create a health hazard.

The inhalation route of exposure will be minimized by the wearing of respirators containing high efficiency particulate air (HEPA) filters. Lead ingestion will be prevented by protective clothing (see section on protective clothing) and sanitation.

2.0 OCCUPATIONAL STANDARDS

The Occupational Safety and Health Administration (OSHA) has a standard covering occupational exposure to lead. The lead standard is referenced as Title 29 Code of Federal Regulations Part 1910.1025 (29 CFR 1910.1025, Appendix C). The OSHA standard for sulfuric acid is referenced as 29 CFR 1910.1000. Occupational health standards define allowable exposures to lead and sulfuric acid. The exposure standards are based on an 8-hour time-weighted average air sample collected in the breathing zone of workers. Employee exposure is meant to be that which would occur if the employee was not wearing a respirator.

The following Table summarizes the permissible exposure limits (PEL) and "action level" of the Occupational Safety and Health Administration. The action level is the airborne concentration at which certain provisions such as medical surveillance are required as defined in 1910.1025 (included in the appendix). Sulfuric acid does not have an OSHA specified action level.

| | <u>PEL</u> | <u>Action Level</u> |
|---------------|--|----------------------|
| Lead | 0.05 mg/m ³ (50 ug/m ³) | 30 ug/m ³ |
| Sulfuric Acid | 1.0 mg/m ³ | ----- |

For exposures to lead; if personnel work longer than eight (8) hours in any work day, the permissible exposure limit as a time-weighted average (TWA) shall be reduced according to the following formula:

maximum permissible limit in micrograms (ugs) per cubic meter of air = $400 / \text{hours worked in the day}$

3.0 AIR MONITORING

3.1 PURPOSE

Air monitoring is necessary to define potential exposures to lead contaminated dusts. Air samples collected within the breathing zone of personnel will determine compliance with 1910.1025 and will be used in conjunction with biological monitoring to assure that no workers absorb an unhealthy amount of lead.

Perimeter monitoring will be done to assure that migration of lead offsite is minimized. Perimeter samples will also be collected prior to site cleanup activities to determine background levels of lead.

3.2 METHODS AND PROCEDURES

Personal monitoring will be employed during the soil excavation work. Personal exposure studies will be conducted in accordance with 29 CFR 1910.1025.

GSX will select the employee(s) expected to have the highest potential exposure and place a battery operated personal air sampling pump and filter media on this person(s). A breathing zone sample will be collected. Full period single sample time-weighted average measurements will be determined. The sample(s) will be obtained for the full work period (normally 8 hours).

The employee(s) with maximum expected exposure will be selected for breathing zone sample collection. When a number of work operations exist, one or more maximum risk employees will be selected for each work operation. The judgement of the maximum risk employee(s) will be determined by observation of work activities by the onsite Safety and Health Officer with consultation from the project manager or other appropriate individuals. Employee mobility, work tasks, and methods of performing the tasks, wind direction, source of generation of dust, and observation of work activities will be used to determine personal sampling. If a maximum risk employee cannot be selected for an operation or job task with reasonable certainty, then random sampling from the group of workers will be used.

The objective of the procedure is to select a subgroup of adequate size so that there is a high probability that the random sample will contain at least one worker with high exposure if one exists. The following Table indicates the required sample size:

| Size of Group | Number of Samples Recommended |
|---------------|-------------------------------|
| 8 | 7 |
| 9 | 8 |
| 10 | 9 |
| 11 - 12 | 10 |

(N if N is less than 7)

A 24-hour turnaround time will be requested on the initial set of personal exposure samples. If the results are less than the action level, further daily monitoring will not be necessary. If conditions or operations change, additional personal air samples will be collected to represent potential exposures.

Personal monitoring will be conducted periodically (at least once a week) if the initial sampling does not indicate levels above the action level. If levels of exposure exceed the action level additional air samples each day will be conducted.

All air sampling equipment will be calibrated with the air sampling media in-line following standard industrial hygiene procedures.

4.0 MEDICAL SURVEILLANCE

4.1 PURPOSE

The primary objective of health protection is to minimize the airborne concentrations of lead and sources of lead ingestion. Medical surveillance is a secondary tool to assure that workers are protected from the adverse effects of lead.

4.2 BLOOD LEAD

OSHA requires medical surveillance of all workers occupationally exposed to lead above the action level for more than 30 days per year. All GSX employees have baseline blood and urine lead determined in preemployment physical examinations. These baseline parameters are considered sufficient as the entry medical monitoring requirement. In addition, blood and urine lead levels are monitored annually in annual physical examinations.

At the conclusion of the Ulah Battery project, an exit blood sample will be collected and analyzed for the presence of lead. If air sampling data indicate airborne concentrations of lead above the action level, blood lead will be obtained to determine the adequacy of personal protective equipment.

4.3 MEDICAL REMOVAL

Employee(s) whose blood lead levels exceed 40 ug/100g of whole blood shall be notified in writing of the biological monitoring results and the affected employee will be removed from work at the site. In addition, a second (follow-up) blood test will be given to the affected employee at most two weeks after GSX receives the results of the first blood sampling test. All medical procedures will be performed under the supervision of a licensed physician.

5.0 SITE SAFETY

In completing the Ulah Battery Reclamation project, the health and safety of all GSX on-site personnel, state and federal representatives, and the public, as well as the protection of the environment, shall be of paramount importance. With this in mind, general health and safety policies and procedures have been developed, and will be implemented by the GSX Project Manager and/or safety officer. OSHA standards and regulations contained in Department of Labor, Title 29 Code of Federal Regulations, Part 1910, and the applicable recommendations by the National Institute for Occupational Safety and Health (NIOSH) regarding procedures to ensure safe operations represent the basis for GSX's Health and Safety Program. These policies will take precedence over cost and scheduling of all site project activities. All GSX personnel, subcontractors, state and federal representatives, and visitors shall abide by these requirements.

5.1 GENERAL SAFETY RULES

1. Prior to the start of each work day, a morning meeting shall be held for all GSX personnel. Necessary safety procedures, safe work practices, site evacuation and escape procedures, and the planned daily activities will be reviewed during these meetings.
2. Provisions will be made for first aid for all on-site personnel. At a minimum, a first aid kit will be on site. The location of the first aid kit supplies will be reviewed at the morning meetings.
3. Eating, smoking, and drinking are strictly prohibited in both the contaminated and decontamination zones. Designated areas will be provided in the clean zone for these activities.
4. Fire extinguishers shall be provided at active work locations within the contaminated zone. At a minimum, fire extinguishers shall be 20 pound, ABC dry chemical type.
5. All tools and equipment, where necessary, shall be spark proof, explosion proof, and/or grounded and bonded.
6. All atmosphere supplied respiratory devices shall meet at least the requirements of the specifications for Grade D breathing air as described in Compressed Gas Association Commodity Specification G-7.1-1966.
7. Should site evacuation be necessary, one employee shall be assigned the duty of alerting all personnel on site. A plan shall be developed for this event and shall be reviewed at morning meetings.

8. All staff shall have medical clearance which includes a physical exam and appropriate bloodwork.

9. No person shall be assigned to a task that requires the use of respiratory protection until it is determined that he/she is physically capable of using such devices. This determination shall be made by a physician.

10. Beards, facial hair, and sideburns (that may interfere with the sealing portion of a respirator) are prohibited for all personnel entering the contamination and decontamination zones (including contractors, subcontractors, visitors, and state and federal representatives).

11. Parking of all nonessential vehicles outside the designated parking area shall be prohibited since safe egress ingress areas may be obstructed.

12. All personnel shall use one entrance and exit from the contaminated zone. This shall be true with the exception of immediately life and health threatening situations.

13. The Project Manager shall have the authority to remove anyone from the site and prohibit his/her reentry should it be determined that that person threatens site security or the safety of on-site personnel.

14. An emergency eyewash/safety shower unit will be provided at the site.

15. All accidents and incidents must be reported, no matter how slight. All incidents will be investigated and analyzed by the GSX Project Manager or his designated representative. Any serious injury to personnel or property will be reported to the DHR representative by the most rapid means available.

5.2 SITE WORK ZONES

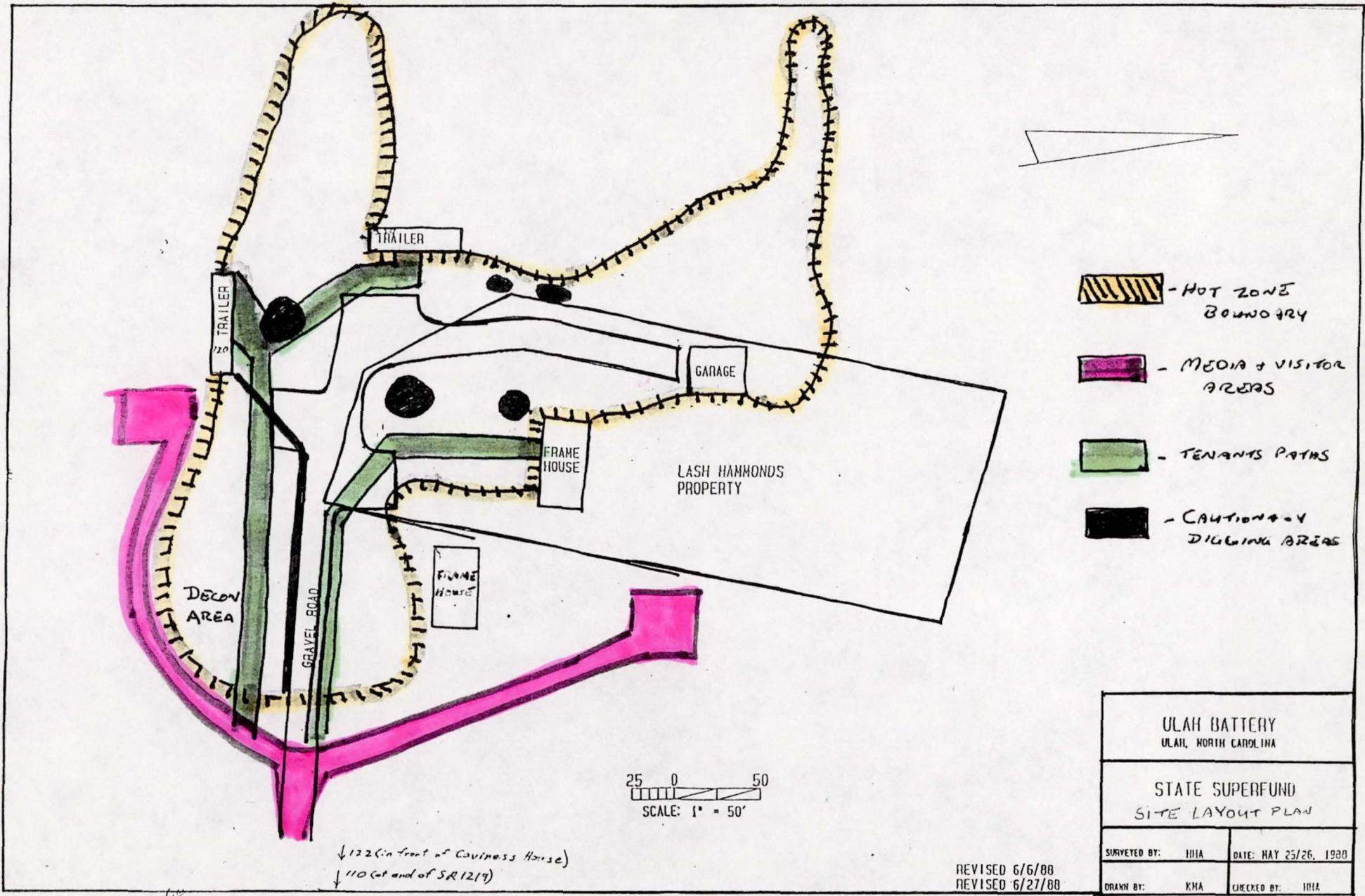
The purpose of site work zones is to minimize the spread of lead and sulfuric acid contaminated materials by workers or equipment from the contaminated area to the clean area. The establishment of work zones will help ensure that personnel are properly protected against the hazards present where they are working, work activities and contamination are confined to the appropriate area, and personnel can be located and evacuated in case of emergency. The work area will be divided into three work zones; exclusion zone, contamination reduction zone and support zone.

The exclusion zone is the area where contamination occurs. The primary activities performed in the exclusion zone are the excavation of lead and sulfuric acid contaminated soils. The outer boundary of the exclusion is the hotline. The hotliune will be clearly marked by warning cones, warning tape, drums or other appropriate means. Access control will be established at the hot line to regulate the flow of personnel and equipment into and out of the zone of maximum contamination and to help verify that proper procedures are followed before entering or exiting. All personnel within the exclusion zone will wear the required personal protective equipment (Level C protection).

The contamination reduction zone is the transition area between the contaminated area and the clean area. The zone is designed to minimize the possibility that the clean support zone will become contaminamated or affected by other site hazards. The distance between the exclusion zone and contamination reduction zone minimizes the physical transfer of hazardous lead and sulfuric acid contaminated substances into the clean area. Decontamination procedures will take place in a designated area within the contamination reduction zone. Access to the contamination reduction zone will be through two areas. One area will be for equipment entrance and exit and the other area will be for personnel entrance and exit.

The support zone will be a clean area with location of the command post, administrative, and other support functions. Any function that need not be performed in the exclusion or contamination reduction zone will be done here. Personnel will wear normal work clothes in the support zone. Any potential contaminated clothing will remain in the contamination reduction zone until decontaminated. All emergency telephone numbers will be posted in the clean area.

All three areas will be located and marked on a map before work begins.



-  - HOT ZONE BOUNDARY
-  - MEDIA + VISITOR AREAS
-  - TENANTS PATHS
-  - CAUTIONARY DIGGING AREAS

25 0 50
 SCALE: 1" = 50'

↓ 122 (in front of Caviness House)
 ↓ 110 (at end of SR 1219)

| | |
|--------------------------------------|-----------------------|
| ULAH BATTERY ULAH, NORTH CAROLINA | |
| STATE SUPERFUND SITE LAYOUT PLAN | |
| SURVEYED BY: IIIA | DATE: MAY 25/26, 1980 |
| DRAWN BY: KMA | CHECKED BY: IIIA |

REVISED 6/6/88
 REVISED 6/27/88

6.0 PROTECTIVE EQUIPMENT

6.1 INTRODUCTION

Work at a hazardous waste remediation site can present chemical, physical, and biological hazards to workers. Protective measures must be implemented to reduce these hazards. These measures can take three forms:

1. Engineering controls
2. Work practices
3. Protective equipment

The Occupational Safety and Health Administration (OSHA) places the emphasis for compliance on engineering controls and work practices first. The usage of protective equipment is allowed when the first two measures are not practical or feasible. In its' recent regulation for waste site operations (1910.120) OSHA has realized that a greater reliance on protective equipment is necessary because of the changing nature of waste sites. Due to the uncertainty of sites and the subsequent inability to predict all hazards, engineering controls and work practices can be incomplete at best and ineffective at the worst.

GSX, however, has several standard procedures that can be used at Ulah Battery. These include the use of water and a chemical dust suppressant to reduce dust exposure and migration, heavy equipment for remote handling of wastes, the use of the buddy system, and certain communication methods. See section 5.1 (General Safety Rules) for further work practices. All these control measures are designed to reduce the chance of exposure of workers and the general public. By properly using these methods the off-site migration of contamination is prevented.

6.2 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE), in the form of clothing and respiratory protection, is an employees first line of defense against an unexpected incident. The levels of PPE warranted by a situation are dependent on the hazard, work operation, area, and to a lesser degree, temperature. The goal of protective equipment is to offer the highest level of protection to the employee. The degree and kind of known or unknown chemical, the situation or the nature of the work being done, the general area full of inherent or potential dangers, as well as the physiological stress factors, determine the types of protective equipment required.

An effective program must address the human element. Temperatures, either hot or cold, dramatically affect the employee wearing protective equipment. The resistance offered by the respirator to breathing and the appreciable weight of some units defines the amount of time that it can be used daily. Other factors, like the need for flexible clothing that will not impede

movement or limit body action, influence the selection of protective equipment. Acknowledgement of the human stress factor is important, for it will determine the amount of cooperation and strict adherence to the safety guidelines that can be expected from the employee.

Generally, it is necessary to provide protection for the exposed person for the three routes of entry which are:

1. Ingestion
2. Inhalation
3. Skin absorption

The protection from contamination due to ingestion is simply managed. EATING, DRINKING, and SMOKING are prohibited in the work area. All employees must leave the contaminated work area completely for the break, remove protective clothing, wash hands thoroughly or shower, and spend the rest or lunch time in an uncontaminated, designated area.

The question of protection from contamination due to inhalation and absorption is complex. The very broad range of hazards, situations, work areas, and tasks will determine the appropriate protective equipment used on-site.

The Ulah Battery site has shown to be contaminated with lead and anhydrous sulfuric acid. The hazards associated with these materials are discussed in Section 1.0. In order to protect the workers the following protective equipment will be worn. Respiratory protection is covered as separate item.

1. Regular Tyvek
2. Polyboots with steel toe and shank.
3. Neoprene or neoprene/latex inner gloves.
4. Leather outer gloves.
5. Hardhat (optional).

All protective clothing, with the exception of the polyboots, is disposable and will be placed in containers for disposal as a hazardous waste. All GSX personnel are trained in the proper donning and doffing of their protective equipment. This procedure includes turning the suit inside-out as it is removed, touching only the outside of the suit, and removing the respirator after removal of the suit. The polyboots will be decontaminated after each use. Decontamination is covered in another section of this plan.

Work uniforms will be cleaned by a commercial laundry that GSX utilizes. This laundry service has been informed of the nature of GSX's business and its hazards and has taken appropriate protective measures for its employees.

6.3 RESPIRATORY PROTECTION

Respiratory protection at the Ulah Battery site is regulated by the OSHA Lead Standard (1910.1025). Under this regulation an employer is required to provide respiratory protection when engineering controls or work practices are not feasible or do not reduce airborne concentrations to a level below the Permissible Exposure Limit (PEL) of 50 micrograms per cubic meter of air. Section 1910.1025 has a table for determining the level of respiratory protection required. It is shown, in part, below.

| <u>Airborn Concentration of lead</u> | <u>Required Respirator</u> |
|---|---|
| <u>Not in excess of .5 milligrams per cubic meter (10 x PEL)</u> | <u>Half mask, air purifying respirator with high efficiency filters</u> |
| <u>Not in excess of 2.5 milligrams per cubic meter (50 x PEL)</u> | <u>Full facepiece air puri- fying respirator with high efficiency filters</u> |
| <u>Not in excess of 50 milligrams per cubic meter (100 x PEL)</u> | (1) Any powered air puri- fying respirator with high efficiency filters OR (2) Half mask supplied air respirator operated in a positive pressure mode. |

GSX intends to use a full or half-facepiece air purifying respirator with organic vapor/acid gas cartridges with high efficiency particulate air (HEPA) filters in situations of concentrations up to, and including, 2.5 milligrams per cubic meter. Above this level a full facepiece supplied air respirator operating in the positive pressure mode will be used. If air monitoring allows protective equipment will be downgraded to regular tyvek, work shoes, safety glasses, and dust mask (if necessary).

GSX's Respiratory Protection Program is in accordance with the OSHA Act Section 1910.134. The program is maintained at GSX offices. All GSX personnel entering the site has been trained in the proper selection and use of air purifying devices as well as their limitations. A facial hair policy has been instituted in accordance with Section 1910.134(5) (e) (1) All GSX personnel entering the site have been fit tested as per the Lead Standard. All GSX personnel required to use atmosphere supplying devices such as airline respirators and self-contained breathing

apparatus have been properly trained in their use and limitations. All respiratory protective devices shall be inspected and stored as per OSHA 1910.134. All respiratory protective devices worn shall be cleaned and sanitized once per day and more often as needed. All GSX personnel have been trained in the proper methods for inspecting, cleaning, maintaining, and storing their respiratory protection.

6.4 HEAT STRESS

Heat stress can exist at hazardous waste work sites. Chemically resistant clothing prevents the evaporation of perspiration. The wearing of vapor barrier clothing greatly increases the potential for heat stress and heat induced illness. A heat stress disorder can result if minerals and liquids are not adequately replaced or if the body's cooling mechanism fails. Heat stress is a combination of environmental and physical work factors that can cause heat rash, heat cramps, heat exhaustion, and heat stroke. It may be necessary to monitor workers at frequent intervals and to provide a work/rest regimen to ensure that heat stress disorders do not occur.

Heat stress measurements, based on heart rate, will be obtained periodically to determine the proper work/rest ratio. There are currently no federal standards addressing the measurement and permissible exposure to heat stress so the recommendations of the American Conference of Governmental Industrial Hygienists (ACGIH) will be used. An electrolyte fluid replacement such as Squincher will be available for site workers. Core body temperature readings are the best method for evaluating heat stress but are difficult to achieve in the field. Therefore environmental parameters will be collected to help determine work/rest regimens.

Environmental conditions may be monitored by determining dry bulb thermometer temperatures, a measurement of radiant heat, wet bulb temperatures, and corresponding relative humidities. This information can be used in conjunction with the ACGIH recommendations to determine proper work/rest regimens.

7.0 DECONTAMINATION

7.1 INTRODUCTION

Decontamination of equipment is also a work practice that helps to reduce the possibility of exposure. Workers are protected from exposure due to permeation or degradation of their protective equipment when this equipment has been properly decontaminated. Decontamination also prevents the migration of waste to clean areas of the site and prevents incompatible chemicals from mixing. Decontamination must be done for both personnel and equipment.

7.2 PERSONNEL DECONTAMINATION

Personnel decontamination is vitally important as it prevents workers from being exposed to hazardous chemicals. The first step in preventing exposure, however, is the prevention of contamination. This can be done in a number of ways including; remote handling, using disposable garments, covering equipment and tools in protective covers, and enclosing the source of contaminants. GSX intends to use heavy equipment for the majority of the waste removal process. If necessary polyethylene plastic can be placed over areas of contamination (or noncontamination) to prevent the spread of the waste.

GSX personnel will be suited in polyethylene coated Tyvek with a hood, chemical gloves, and polyurethane boots. The Tyvek and gloves are disposable. The polyurethane boots are reuseable and must be decontaminated. As personnel leave the exclusion zone and enter the contamination reduction zone they will drop all tools in a designated location and proceed to the decontamination station. This will consist of a series of industrial grade tubs with a solution of 5% sodium carbonate, 5% trisodium phosphate, 10% calcium hypochlorite, and water. Each tub will have a brush for scrubbing. The employee will proceed from tub to tub, scrubbing his suit, gloves, and boots. The final tub will be clean rinse water. After decontamination, the employee will untape his gloves and boots, remove his suit (turning it inside-out as he goes), remove his respirator, then place the suit in the disposal container. After this he will remove his boots and gloves.

In the case of an emergency requiring the decontamination of an injured person, the status of the injured must be evaluated. If the employee can move of his own will, he will proceed to the decontamination station, get assistance with decontamination and receive treatment. If the injury prevents movement, other GSX personnel will decontaminate the person at the site of injury and stabilize. When emergency medical help arrives they will provide with protective equipment so they respond to the site.

7.3 EQUIPMENT DECONTAMINATION

Decontamination of equipment, including vehicles, prevents the transportation of hazardous materials off-site in an uncontrolled manner. This prevents the unprotected surrounding populace from being exposed.

The following procedures will be implemented to minimize the potential for contaminant transfer, off-site contaminant migration, or personnel exposure from improperly decontaminated equipment.

A decontamination pad will be constructed to allow washwater to drain into an excavated on-site waste area. GSX will line this area with three layers of polyethylene plastic.

GSX will use an atomized water solution and/or a steam spray to dissolve and remove exterior contamination. All equipment surfaces will be cleaned. The rinse procedure will be repeated as needed with a water rinse.

GSX will dispose of materials used in the decontamination process by transporting them to GSX Services of SC, Inc. in the last truckload of waste.

8.0 TRAINING

Training personnel how to work at a waste remediation site is important as it insures the safe and efficient completion of the job. Personnel must be thoroughly familiar with the site, its' hazards, the safety plan, work procedures, protective equipment, the contingency plan, and the planned activities at the site.

All GSX personnel have the necessary training and experience to be certified as OSHA 40 training qualified as required by 1910.120 (e). In addition, prior to the start of work at the site GSX personnel will attend a site safety meeting designed to familiarize them with the aforementioned items. This meeting will be recorded in the project logbook with the names of the attendees listed.

On-site personnel will meet daily prior to the commencement of the days' work and on a "significant conditions" basis to discuss safety matters, appropriate personal protective equipment, emergency actions, and general site activities. These meetings will prevent miscommunication and subsequent mishaps from occurring. These meetings will also be documented in the project logbook.

In order to protect emergency services personnel, GSX will invite representatives from the Sheriff's Office, Fire Department, Ambulance Service, and the Hospital Emergency Room to visit the site. At this meeting, GSX will orient them to the site, it's hazards and protective measures necessary for responding to emergencies at the site.

9.0 SITE SECURITY

Because of the proximity of the site to local inhabitants site security is vitally important. Site security helps to prevent:

1. The exposure of unauthorized, unprotected people to site hazards.
2. Unauthorized addition of waste to the site.
3. Vandalism to equipment thus increasing the risk to site workers.
4. Theft of equipment or waste.
5. Interference with site work.
6. Off-site migration of contamination.

For the safety of on-site personnel, visitors, and inhabitants of the local area, GSX will secure the boundaries of the site with barrier tape that is imprinted with the words:

CAUTION : DO NOT ENTER

OR

HAZARDOUS MATERIAL : DO NOT ENTER

OR

CAUTION : ENTRY REQUIRES PROTECTIVE GEAR

These boundaries will establish strict access control points to be used by all personnel and visitors. In addition, if it becomes necessary a more permanent boundary, such as a fence or netting, can be put in place.

All visitors and representatives will be required to sign in and out upon entry and exit at the site and must notify the GSX Project Manager or Team Leader prior to entry to the site. Each visitor must adhere to the site control and safety guidelines in the plan and will be given introductory training prior to entry.

At the end of each day GSX will secure its equipment by locking it and then removing the keys. If circumstances warrant a 24 hour security system can be established.

The Project Manager will be responsible for establishing and maintaining the security measures. If a change becomes necessary or a problem arises the DHR will be notified immediately.

In order to protect it's property and that of the local inhabitants, GSX will arrange for the Sheriff's Department to periodically visit the site during off-hours.

10.0 FIRE SAFETY PROCEDURES

Prior to the start of work at the site, all GSX personnel shall be instructed in basic fire safety including the use of hand-held fire extinguishers. Emphasis will be placed on early detection of a fire, alerting other personnel with a predetermined alarm, and notifying local fire departments. This information shall be reviewed at morning meetings, as necessary.

In the event of a fire, it is imperative to prevent its spread. Most fires begin small and can be easily extinguished if discovered early. The greatest single cause of large fires is delayed discovery and/or incompetent response after detection.

Each GSX person shall be competent in all of the above mentioned areas of fire fighting. Any GSX personnel discovering a fire shall use his voice to alert others while he/she locates the nearest fire extinguishers. Appropriate fire extinguishers shall be located in all active work locations. The second person on the scene shall alert all remaining personnel on site of the fire with a predetermined signal. Persons closest to a telephone shall alert the police and local fire departments. Due to the delay in fire departments arriving at the site, all available personnel shall locate appropriate fire extinguishers and aid in containing the fire. If the fire is extinguished, water shall be used to cool the area to prevent a build up of heat and re-ignition of the area. Water shall not be used on water reactive materials such as combustible metals.

Water is the most commonly used fire extinguishing agent. However, it is inadvisable to use bulk water on a fire involving Class B materials such as oil, gasoline, paints, and solvents, since they are usually less dense than water and may be physically displaced by the impact of the water stream. The result would be to scatter the material and increase the spread of the fire. Water is usually effective when it is applied in the form of fine droplets or spray. This has a blanketing effect and avoids the difficulty of impact splattering of the material. Water shall be used if all available extinguishing agents are depleted and if it is used as a spray to smother the fire or cool surrounding areas and already extinguished areas.

Fire extinguishers to be used at the Ulah Battery site are the dry chemical type. Fire extinguishers shall be located at all active work locations and on all heavy equipment. Inspection of available portable fire extinguishers shall be the responsibility of the GSX Project Manager. Inspections shall be conducted weekly.

11.0 PREPAREDNESS, CONTINGENCY AND EMERGENCY PLAN

11.1 INTRODUCTION

The primary goal of any remedial operation is to remove the hazardous material without causing any damage to the workers or the environment. The site work plan and Health and Safety Plan are designed to help achieve this goal by developing the policies and procedures and by designating the proper equipment to be used during the operation. A major constituent of the Health and Safety Plan is the Preparedness, Contingency and Emergency Plan which is put together to map out specific actions to be taken for various incidents that may occur.

Prior to any on-site operations, GSX shall develop Preparedness, Contingency and Emergency Plans for the specific operations. The plan will follow the guidelines set forth under the Resource Conservation and Recovery Act (RCRA) and will go beyond these guidelines and address possible emergency situations that have the potential to present problems. Topics to be addressed include, but will not be limited to, emergency telephone numbers, specific response actions for on the scene personnel, emergency coordinators, employee training, implementation, and evacuation plans. Emergency numbers for fire, rescue, police, and hospital will be placed in a conspicuous place.

Before on-site operations begin, GSX personnel will be indoctrinated to the procedures established for the site. Training programs will be presented and all on-site personnel made aware of emergency procedures, their individual responsibilities, and the health and safety procedures that will be enforced.

At the Ulah Battery site there are 5 types of incidents that could occur and they are listed in order of severity.

1. Injuries
2. Fire
3. Spills
4. Release
5. Off-site (transportation) incidents

Before specific response actions can be detailed certain general items that concern every incident must be planned for.

1. Communications - Use of voice is the primary means of communication. A series of hand signals will be developed as a backup method. If site conditions necessitate radios can be used. Air horns and vehicle horns will also be used for emergency notification

2. Evacuation plan and assembly areas - If evacuation of the work area becomes necessary then the GSX Project Manager will notify on-site personnel as to the necessity of evacuation and the assembly area. Primary and secondary assembly points will be designated prior to the start of work. Once evacuation is complete the GSX Project Manager will conduct a head count and report to the DHR representative. If evacuation of the surrounding neighborhood becomes necessary (a DHR decision) all GSX personnel will assist in alerting local authorities, containing the incident, and the evacuation of the neighborhood.

3. Personal protective equipment and emergency equipment - In addition to the protective equipment employees will be wearing during normal work activities, certain emergency equipment will be available. This includes, but is not limited to, dry chemical fire extinguishers, supplied air breathing systems, saranex Tyvek, harnesses and lifelines, stretcher, first aid kit, and an eyewash/shower unit.

4. Rescue procedures - If rescue of injured personnel becomes necessary the several actions must occur before rescue takes place.

a. The employee noticing the rescue situation will notify the GSX Project Manager and other workers.

b. The GSX Project Manager will notify the DHR representative.

c. If the cause of the situation is known and does not pose an exposure problem to other personnel (injury due to mechanical means rather than chemical exposure) the GSX Project Manager will direct the rescue attempt as long as such rescue does not expose other employees to possible harm.

d. If the cause of the situation is unknown or presents a chemical exposure problem the GSX Project Manager will direct all remaining employees to return to the decontamination zone. There, one or more persons will be suited in a saranex Tyvek and supplied air respirators with harnesses and lifelines attached. They will then attempt rescue. The exposed employee will be removed to the decontamination zone, decontaminated, unsuited, and first aid will be administered.

e. Outside medical help will be notified for transport and treatment.

5. After hours/Weekend notification - If a situation arises after hours or during the weekend, management must be notified. The following list will be used.

| <u>NAME</u> | <u>WORK HOURS #</u> | <u>AFTER HOURS #</u> |
|--|---------------------|------------------------------|
| Randy Garner GSX Project Manager | N/A | 919-282-3412 |
| Bernard Jones GSX Director, Remedial Operations | 919-342-6106 | 803-389-2000 |
| Gary Campbell GSX Operations Manager | 919-342-6106 | 919-288-0775 615-822-7842 |
| Don Lowe GSX Engineering Manager | 919-342-6106 | 919-230-0352 |
| Steve Thomas GSX Health & Safety Officer | 919-342-6106 | 919-375-6106 6433 |

6. Personnel Roles - In the event of an emergency, the GSX Project Manager will be in charge of all actions. In the event of his needing to leave the site, the GSX Project Team Leader will be in charge. All other personnel will be and can be used in an emergency as required.

7. Training - All personnel will be trained in the emergency plan, its requirements as to response actions, emergency equipment, evacuation and assembly, personnel roles and notification procedures.

8. Off-site Services - In order to provide for prompt response of emergency service groups, GSX will invite representatives from the Sheriff's Department, Fire Department, Ambulance Service, and the Hospital Emergency Room to visit the site, learn of its hazards and the proper protective measures needed for responding to the site.

9. Emergency Decontamination - In the case of an injury on-site the employee must be evaluated as to the possibility of movement. If the employee is not injured seriously and can move on his own, he will proceed to the decontamination station and receive assistance. If the injured cannot move on his own but the injury does not preclude movement other GSX personnel will transport the injured to the decontamination station, decontaminate and stabilize the person until emergency help arrives. If movement of any type is not possible, the injured will be stabilized and decontaminated (or isolated

from contamination) at the site of injury. Responding emergency services personnel will be given protective equipment to use to enter the site.

10. Critique and followup - After an incident has occurred and has been eliminated the GSX Project Manager and the DHR representative will evaluate the response procedures and equipment and make any changes. All damaged or used emergency equipment will be repaired or replaced before work restarts.

11.2 SPECIFIC RESPONSES

Now that the groundwork for an emergency plan has been laid the specific actions for each type of incident can be detailed.

11.2.1 INJURY

1. The employee discovering the incident/injury will notify all other on-site personnel by:
 - a. Voice
 - b. Vehicle horn/Air horn
 - c. Hand signals
 - d. Radio (if used)
2. The GSX Project Manager will notify the DHR representative.
3. If rescue is necessary it will be done as detailed earlier.
4. The injured person will be moved to the decontamination zone, decontaminated and unsuited.
5. On-site medical aid will be rendered.
6. The injured will be transported to the nearest hospital.
7. The GSX Project Manager will notify GSX of the incident.

11.2.2 FIRE

1. The employee discovering the fire will notify all other on-site personnel by:
 - a. Voice
 - b. Vehicle horn/Air horn
 - c. Hand signals
 - d. Radio (if used)
2. The GSX Project Manager will notify the DHR representative.
3. The GSX Project Manager will direct on-site activities for controlling the fire. These actions may include using dry chemical fire extinguishers or the heavy equipment to smother the fire with soil.
4. If rescue becomes necessary it will be done as detailed earlier.

5. If evacuation becomes necessary it will be done as detailed earlier.
6. The GSX Project Manager will notify GSX Management as soon as possible.

11.2.3 SPILLS/RELEASES

1. The employee discovering the spill will notify all other on-site personnel by:
 - a. Voice
 - b. Vehicle horn/Air horn
 - c. Hand signal
 - d. Radio (if used)
2. The GSX Project Manager will notify the DHR representative.
3. The GSX Project Manager will direct on-site activities to contain and control the spill. This may include using the heavy equipment to cover and berm the spill with soil or pumping up contained liquids.
4. Evacuation and rescue will be done in the manner detailed earlier if it becomes necessary.
5. The GSX Project Manager will notify GSX Management as soon as possible.

11.2.4 OFF-SITE INCIDENTS

1. Any driver involved in an off-site incident will immediately notify the local police and the GSX Project Manager. The GSX Project Manager will advise the driver.
2. The GSX Project Manager will notify the DHR representative.
3. The GSX Project Manager will notify GSX Management and appropriate outside agencies (Fire Department, National Response Center, Coast Guard, etc.).
4. GSX will provide emergency response to the site of the incident.

APPENDIX A

EMERGENCY NUMBERS
AND
DIRECTIONS TO HOSPITAL

EMERGENCY PHONE NUMBERS

RANDOLPH EMERGENCY SERVICES

Fire and Ambulance 919-625-1600
Neil Allen, Director 919-629-2731(W)
919-625-1831 (24hr)

RANDOLPH COUNTY SHERIFF 919-629-9128

NORTH CAROLINA HWY. PATROL 800-662-7956

RANDOLPH GENERAL HOSPITAL EMERGENCY ROOM 515-625-5151
Peggy Slack, RN
Eric Helsabeck, MD

NORTH CAROLINA DEPARTMENT OF HUMAN RESOURCES

DIVISION OF HEALTH SERVICES

Superfund Branch 919-733-2801
Occupational Health Services 919-733-3680

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES
AND COMMUNITY DEVELOPMENT

Division of Environmental Management 919-761-2351

NORTH CAROLINA DEPARTMENT OF CRIME CONTROL AND
PUBLIC SAFETY

Division of Emergency Management 919-733-3867

CHEMTREC 800-424-9300

NATIONAL RESPONSE CENTER 800-424-8802

GSX SERVICES, INC. - REIDSVILLE 919-342-6106
800-882-6548

WEEKEND/AFTER HOURS NOTIFICATION

| <u>NAME</u> | <u>AFTER HOURS</u> | <u>WEEKENDS</u> |
|--|--------------------|------------------------------|
| Randy Garner GSX Project Manager | TBA (Call GSX) | 919-282-3412 |
| Bernard Jones GSX, Director, Remedial Services | | 803-389-2000 |
| Gary Campbell GSX Operations Manager | 919-288-0775 | 919-288-0775 615-822-7842 |
| Don Lowe | 919-230-0352 | 919-230-0352 |
| Steve Thomas GSX Health & Safety Officer | 919-375-6433 | 919-375-6433 |

DIRECTIONS TO RANDOLPH GENERAL HOSPITAL

1. Take State Road 1219 (Gravel Road) to end.
2. Make left onto Business 220.
3. Take Business 220 into Asheboro Past US64 and Salisbury Street (Hwy. 42).
4. The hospital is on the left 2 to 3 blocks past Salisbury Street.

APPENDIX B

HEAT STRESS SIGNS AND TREATMENT

HEAT STRESS MANAGEMENT

I. HEAT STRESS: Combination of environmental & physical work factors that equal total have load on the body.

- A. Four Factors That Effect Heat Stress
1. Air temperatures
 2. Air velocity
 3. Moisture content of air
 4. Radiant temperature

II. HEAT DISORDERS:

- A. Prickly Heat (Heat Rash) - blocked sweat glands with resulting inflammation and rash with irritation
1. Symptomns and signs
 - a. Red, small rash in effected areas
 2. Treatment
 - a. Keep cool
 - b. Dry off
 - c. Corn starch
 - d. Dry clothing
- B. Heat Cramps - painful, involuntary muscle spasms, resulting in loss of salt through sweating in hot environments with temperatures > 100°F
1. Symptoms and signs
 - a. Supine with flexed legs
 - b. Great pain - abdomen
 - c. Skin - pale and wet
 2. Treatment
 - a. Remove worker from hostile environment
 - b. Place worker in flat position if possible
 - c. Remove worker from protective clothing & place in cool area
 - d. Proper fluid replacement with Gatorade or other electrolyte replacement fluid
- C. Heat Exhaustion - abnormal vascular response to excessive heat, body temperature is either normal or subnormal.
1. Symptoms and signs
 - a. Rapid pulse
 - b. Pale or ashen skin
 - c. Cold, damp skin
 - d. Possible profuse sweating
 - e. Weakness, dizziness, vertigo

- f. Nausea and vomiting
 - g. Headache
 - h. Dim or blurred vision
 - i. Irritability with muscle cramps
 - 2. Treatment
 - a. Remove worker from hostile environment
 - b. If conscious give cool water
 - c. Change out of damp clothing & wear ventilated clothes
 - d. Seek medical help
 - e. Give adequate fluids for proper urinary output
- D. Heat Stroke - high fever & collapse of worker due to disturbance of heat regulating mechanism resulting in coma, brain damage, and eventual death if left untreated. This comes from prolonged exposure to elevated core temperatures.
- 1. Symptoms and signs
 - a. Weakness
 - b. Headache
 - c. Nausea and vomiting
 - d. Chest discomfort prior to collapse
 - e. Flush, hot, dry to slightly moist skin
 - f. Muscle cramps
 - g. Anxiety or listless appearance
 - h. Pulse greater than 160
 - i. Body temperature of 105° - 106°F
 - j. Respirations 20-30 per minute
 - k. Rapid increase in temperature
 - l. Coma leading to death
 - 2. Treatment
 - a. Immediate hospital or physician care
 - b. Remove worker from heat
 - c. Vigirously massage skin
 - d. Ice water bath or soaks
 - e. Nothing by mouth if unconscious
 - f. CPR if needed to assist patient with ventilations and circulation

III. CONCLUSION

- A. Prevention
 - 1. Frequent breaks in hot weather
 - 2. Increased fluids intake to prevent dehydration
 - 3. Stop work at first sign of problem
 - 4. Seek emergency medical care with heat exhaustion, heat cramping or heat stroke
 - 5. Wear dry, well ventiluted clothing
 - 6. Recognize abnormal behavior in co-hort worker.

/lkn

APPENDIX C

THE OSHA LEAD STANDARD
29 CFR 1910.1025

with constipation, pigmentation and eruption of the skin, loss of hair, and peripheral neuritis. Chronic hepatitis and cirrhosis have been described. Polyneuritis may be the salient feature, but more frequently there are numbness and parasthenias of "glove and stocking" distribution. The skin lesions are usually melanotic and keratotic and may occasionally take the form of an intradermal cancer of the squamous cell type, but without infiltrative properties. Horizontal white lines (striations) on the fingernails and toenails are commonly seen in chronic arsenical poisoning and are considered to be a diagnostic accompaniment of arsenical polyneuritis.

Inhalation of inorganic arsenic compounds is the most common cause of chronic poisoning in the industrial situation. This condition is divided into three phases based on signs and symptoms.

First Phase: The worker complains of weakness, loss of appetite, some nausea, occasional vomiting, a sense of heaviness in the stomach, and some diarrhea.

Second Phase: The worker complains of conjunctivitis, a catarrhal state of the mucous membranes of the nose, larynx, and respiratory passage. Coryza, hoarseness, and mild tracheobronchitis may occur. Perforation of the nasal septum is common, and is probably the most typical lesion of the upper respiratory tract in occupational exposure to arsenical dust. Skin lesions, eczematoid and allergic in type, are common.

Third Phase: The worker complains of symptoms of peripheral neuritis. Initially of hands and feet, which is essentially sensory. In more severe cases, motor paralysis occurs. The first muscles affected are usually the toe extensors and the peronei. In only the most severe cases will paralysis of flexor muscles of the feet or of the extensor muscles of hands occur.

Liver damage from chronic arsenical poisoning is still debated, and as yet the question is unanswered. In cases of chronic and acute arsenical poisoning, toxic effects to the myocardium have been reported based on EKG changes. These findings, however, are now largely discounted and the EKG changes are ascribed to electrolyte disturbances concomitant with arsenicalism. Inhalation of arsenic trioxide and other inorganic arsenical dusts does not give rise to radiological evidence or pneumoconiosis. Arsenic does have a depressant effect upon the bone marrow, with disturbances of both erythropoiesis and myelopoiesis.

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Holmquist, L. 1951. Occupational arsenical dermatitis: a study among employees at a copper-ore smelting works including investigations of skin reactions to contact with arsenic compounds. *Acta. Derm. Venereol.* (Supp. 26) 31:1.

Pinto, S. S., and C. M. McGill. 1953. Arsenic trioxide exposure in industry. *Ind. Med. Surg.* 22:281.

Pinto, S. S., and K. W. Nelson. 1976. Arsenic toxicology and industrial exposure. *Annu. Rev. Pharmacol. Toxicol.* 16:95.

Vallee, B. L., D. D. Ulmer, and W. E. C. Wacker. 1960. Arsenic toxicology and biochemistry. *AMA Arch. Indust. Health* 21:132.

III. SPUTUM CYTOLOGY

Sputum can be collected by aerosol inhalation during the medical exam or by spontaneous early morning cough at home. Sputum is induced by transoral inhalation of an aerosolized solution of eight per cent (8 percent) sodium chloride in water. After inhaling as few as three to five breaths the subject usually yields an adequate sputum. All sputum should be collected directly into sixty percent (60 percent) alcohol.

Scientific evidence suggests that chest X-rays and sputum cytology should be used together as screening tests for lung tests for lung cancer in high risk populations such as workers exposed to inorganic arsenic. The tests are to be performed every six months on workers who are 45 years of age or older or have worked in the regulated area for 10 or more years. Since the tests seem to be complementary, it may be advantageous to alternate the test procedures. For instance, chest X-rays could be obtained in June and December and sputum cytologies could be obtained in March and September. Facilities for providing necessary diagnostic investigation should be readily available as well as chest physicians, surgeons, radiologists, pathologists and immunotherapists to provide any necessary treatment services.

[43 FR 19624, May 5, 1978; 43 FR 28472, June 30, 1978, as amended at 45 FR 35282, May 23, 1980]

§ 1910.1025 Lead.

(a) *Scope and application.* (1) This section applies to all occupational exposure to lead, except as provided in paragraph (a)(2).

(2) This section does not apply to the construction industry or to agricultural operations covered by 29 CFR Part 1928.

(b) *Definitions.* "Action level" means employee exposure, without regard to the use of respirators, to an airborne concentration of lead of 30 micro-

grams per cubic meter of air (30 $\mu\text{g}/\text{m}^3$) averaged over an 8-hour period.

"Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

"Director" means the Director, National Institute for Occupational Safety and Health (NIOSH), U.S. Department of Health, Education, and Welfare, or designee.

"Lead" means metallic lead, all inorganic lead compounds, and organic lead soaps. Excluded from this definition are all other organic lead compounds.

(c) *Permissible exposure limit (PEL).*

(1) The employer shall assure that no employee is exposed to lead at concentrations greater than fifty micrograms per cubic meter of air (50 $\mu\text{g}/\text{m}^3$) averaged over an 8-hour period.

(2) If an employee is exposed to lead for more than 8 hours in any work day, the permissible exposure limit, as a time weighted average (TWA) for that day, shall be reduced according to the following formula:

$$\text{Maximum permissible limit (in } \mu\text{g}/\text{m}^3) = 400 \div \text{hours worked in the day.}$$

(3) When respirators are used to supplement engineering and work practice controls to comply with the PEL and all the requirements of paragraph (f) have been met, employee exposure, for the purpose of determining whether the employer has complied with the PEL, may be considered to be at the level provided by the protection factor of the respirator for those periods the respirator is worn. Those periods may be averaged with exposure levels during periods when respirators are not worn to determine the employee's daily TWA exposure.

(d) *Exposure monitoring*—(1) *General.* (i) For the purposes of paragraph (d), employee exposure is that exposure which would occur if the employee were not using a respirator.

(ii) With the exception of monitoring under paragraph (d)(3), the employer shall collect full shift (for at least 7 continuous hours) personal samples including at least one sample for each shift for each job classification in each work area.

(iii) Full shift personal samples shall be representative of the monitored employee's regular, daily exposure to lead.

(2) *Initial determination.* Each employer who has a workplace or work operation covered by this standard shall determine if any employee may be exposed to lead at or above the action level.

(3) *Basis of initial determination.* (i) The employer shall monitor employee exposures and shall base initial determinations on the employee exposure monitoring results and any of the following, relevant considerations:

(A) Any information, observations, or calculations which would indicate employee exposure to lead;

(B) Any previous measurements of airborne lead; and

(C) Any employee complaints of symptoms which may be attributable to exposure to lead.

(ii) Monitoring for the initial determination may be limited to a representative sample of the exposed employees who the employer reasonably believes are exposed to the greatest airborne concentrations of lead in the workplace.

(iii) Measurements of airborne lead made in the preceding 12 months may be used to satisfy the requirement to monitor under paragraph (d)(3)(i) if the sampling and analytical methods used meet the accuracy and confidence levels of paragraph (d)(9) of this section.

(4) *Positive initial determination and initial monitoring.* (i) Where a determination conducted under paragraphs (d) (2) and (3) of this section shows the possibility of any employee exposure at or above the action level, the employer shall conduct monitoring which is representative of the exposure for each employee in the workplace who is exposed to lead.

(ii) Measurements of airborne lead made in the preceding 12 months may be used to satisfy this requirement if the sampling and analytical methods used meet the accuracy and confidence levels of paragraph (d)(9) of this section.

(5) *Negative initial determination.* Where a determination, conducted under paragraphs (d) (2) and (3) of

this section is made that no employee is exposed to airborne concentrations of lead at or above the action level, the employer shall make a written record of such determination. The record shall include at least the information specified in paragraph (d)(3) of this section and shall also include the date of determination, location within the worksite, and the name and social security number of each employee monitored.

(6) *Frequency.* (i) If the initial monitoring reveals employee exposure to be below the action level the measurements need not be repeated except as otherwise provided in paragraph (d)(7) of this section.

(ii) If the initial determination or subsequent monitoring reveals employee exposure to be at or above the action level but below the permissible exposure limit the employer shall repeat monitoring in accordance with this paragraph at least every 6 months. The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least 7 days apart, are below the action level at which time the employer may discontinue monitoring for that employee except as otherwise provided in paragraph (d)(7) of this section.

(iii) If the initial monitoring reveals that employee exposure is above the permissible exposure limit the employer shall repeat monitoring quarterly. The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least 7 days apart, are below the PEL but at or above the action level at which time the employer shall repeat monitoring for that employee at the frequency specified in paragraph (d)(6)(ii), except as otherwise provided in paragraph (d)(7) of this section.

(7) *Additional monitoring.* Whenever there has been a production, process, control or personnel change which may result in new or additional exposure to lead, or whenever the employer has any other reason to suspect a change which may result in new or additional exposures to lead, additional monitoring in accordance with this paragraph shall be conducted.

(8) *Employee notification.* (i) Within 5 working days after the monitoring results, the employer shall notify each employee in writing of the results which represent that employee's exposure.

(ii) Whenever the results indicate that the representative employee's exposure, without regard to the permissible exposure limit, the employer shall issue a written notice a statement of the employee's exposure to or below the permissible exposure limit and a description of the action taken or to be taken to reduce the exposure to or below the permissible exposure limit.

(9) *Accuracy of measurement.* The employer shall use a method of monitoring and analysis which has a confidence level of not less than plus or minus 20 percent for airborne concentrations equal to or greater than 30 $\mu\text{g}/\text{m}^3$.

(e) *Methods of compliance.* Where any employee is exposed to lead above the permissible exposure limit for more than 30 days the employer shall implement engineering and work practice controls including administrative controls to reduce and maintain employee exposure to lead in accordance with the implementation schedule in paragraph (d)(2) below, except to the extent the employer can demonstrate that engineering and work practice controls are not feasible. The employer shall implement engineering and work practice controls which can be instituted sufficient to reduce employee exposure to or below the permissible exposure limit, the employer shall nevertheless use them to reduce employee exposure to the lowest feasible level and supplement them by the use of respiratory protection which complies with the requirements of paragraph (d)(7) of this section.

(ii) Where any employee is exposed to lead above the permissible exposure limit, but for 30 days or less the employer shall implement engineering controls to reduce employee exposure to 200 $\mu\text{g}/\text{m}^3$, but thereafter supplement any combination of engineering, work practice (including administrative controls), and respiratory controls to reduce and maintain

this section is made that no employee is exposed to airborne concentrations of lead at or above the action level, the employer shall make a written record of such determination. The record shall include at least the information specified in paragraph (d)(3) of this section and shall also include the date of determination, location within the worksite, and the name and social security number of each employee monitored.

(6) *Frequency.* (i) If the initial monitoring reveals employee exposure to be below the action level the measurements need not be repeated except as otherwise provided in paragraph (d)(7) of this section.

(ii) If the initial determination or subsequent monitoring reveals employee exposure to be at or above the action level but below the permissible exposure limit the employer shall repeat monitoring in accordance with this paragraph at least every 6 months. The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least 7 days apart, are below the action level at which time the employer may discontinue monitoring for that employee except as otherwise provided in paragraph (d)(7) of this section.

(iii) If the initial monitoring reveals that employee exposure is above the permissible exposure limit the employer shall repeat monitoring quarterly. The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least 7 days apart, are below the PEL but at or above the action level at which time the employer shall repeat monitoring for that employee at the frequency specified in paragraph (d)(6)(ii), except as otherwise provided in paragraph (d)(7) of this section.

(7) *Additional monitoring.* Whenever there has been a production, process, control or personnel change which may result in new or additional exposure to lead, or whenever the employer has any other reason to suspect a change which may result in new or additional exposures to lead, additional monitoring in accordance with this paragraph shall be conducted.

(8) *Employee notification.* (i) Within 5 working days after the receipt of monitoring results, the employer shall notify each employee in writing of the results which represent that employee's exposure.

(ii) Whenever the results indicate that the representative employee exposure, without regard to respirators, exceeds the permissible exposure limit, the employer shall include in the written notice a statement that the permissible exposure limit was exceeded and a description of the corrective action taken or to be taken to reduce exposure to or below the permissible exposure limit.

(9) *Accuracy of measurement.* The employer shall use a method of monitoring and analysis which has an accuracy (to a confidence level of 95%) of not less than plus or minus 20 percent for airborne concentrations of lead equal to or greater than 30 $\mu\text{g}/\text{m}^3$.

(e) *Methods of compliance—(1) Engineering and work practice controls.* (i) Where any employee is exposed to lead above the permissible exposure limit for more than 30 days per year, the employer shall implement engineering and work practice controls (including administrative controls) to reduce and maintain employee exposure to lead in accordance with the implementation schedule in Table I below, except to the extent that the employer can demonstrate that such controls are not feasible. Wherever the engineering and work practice controls which can be instituted are not sufficient to reduce employee exposure to or below the permissible exposure limit, the employer shall nonetheless use them to reduce exposures to the lowest feasible level and shall supplement them by the use of respiratory protection which complies with the requirements of paragraph (f) of this section.

(ii) Where any employee is exposed to lead above the permissible exposure limit, but for 30 days or less per year, the employer shall implement engineering controls to reduce exposures to 200 $\mu\text{g}/\text{m}^3$, but thereafter may implement any combination of engineering, work practice (including administrative controls), and respiratory controls to reduce and maintain employee

exposure to lead to or below 50 $\mu\text{g}/\text{m}^3$.

TABLE I—IMPLEMENTATION SCHEDULE

| Industry ¹ | Compliance dates ² | | |
|--|-------------------------------|------------------------------|-----------------------------|
| | 200 $\mu\text{g}/\text{m}^3$ | 100 $\mu\text{g}/\text{m}^3$ | 50 $\mu\text{g}/\text{m}^3$ |
| Primary lead production..... | (3) | 3 | 10 |
| Secondary lead production..... | (3) | 3 | 5 |
| Lead acid battery manufacture..... | (3) | 2 | 5 |
| Automobile manufacture/solder grinding..... | (3) | N/A | 7 |
| Electronics, gray iron foundries, ink manufacture, paints and coatings manufacture, wall paper manufacture, can manufacture, and printing..... | (3) | N/A | 1 |
| Lead pigment manufacture, nonferrous foundries, leaded steel manufacture, lead chemical manufacture, shipbuilding and ship repair, battery breaking in the collection and processing of scrap (excluding collection and processing of scrap which is part of a secondary smelting operation), secondary lead smelting of copper, and lead casting..... | (3) | N/A | N/A |
| All other industries..... | (3) | N/A | 2½ |

¹ Includes ancillary activities located on the same worksite.
² Expressed as the number of years from the effective date by which compliance with the given airborne exposure level, as an 8-hour TWA must be achieved.

(2) *Respiratory protection.* Where engineering and work practice controls do not reduce employee exposure to or below the 50 $\mu\text{g}/\text{m}^3$ permissible exposure limit, the employer shall supplement these controls with respirators in accordance with paragraph (f).

(3) *Compliance program.* (i) Each employer shall establish and implement a written compliance program to reduce exposures to or below the permissible exposure limit, and interim levels if applicable, solely by means of engineering and work practice controls in accordance with the implementation schedule in paragraph (e)(1).

(ii) Written plans for these compliance programs shall include at least the following:

(A) A description of each operation in which lead is emitted; e.g. machinery used, material processed, controls in place, crew size, employee job responsibilities, operating procedures and maintenance practices;

(B) A description of the specific means that will be employed to achieve compliance, including engineering plans and studies used to determine methods selected for controlling exposure to lead;

(C) A report of the technology considered in meeting the permissible exposure limit;

(D) Air monitoring data which documents the source of lead emissions;

(E) A detailed schedule for implementation of the program, including documentation such as copies of purchase orders for equipment, construction contracts, etc.;

(F) A work practice program which includes items required under paragraphs (g), (h) and (i) of this regulation;

(G) An administrative control schedule required by paragraph (e)(6), if applicable;

(H) Other relevant information.

(iii) Written programs shall be submitted upon request to the Assistant Secretary and the Director, and shall be available at the worksite for examination and copying by the Assistant Secretary, Director, any affected employee or authorized employee representatives.

(iv) Written programs shall be revised and updated at least every 6 months to reflect the current status of the program.

(4) *Bypass of interim level.* Where an employer's compliance plan provides for a reduction of employee exposures to or below the PEL solely by means of engineering and work practice controls in accordance with the implementation schedule in table I, and the employer has determined that compliance with the 100 $\mu\text{g}/\text{m}^3$ interim level would divert resources to the extent that it clearly precludes compliance, otherwise attainable, with the PEL by the required time, the employer may proceed with the plan to comply with the PEL in lieu of compliance with the interim level if:

(i) The compliance plan clearly documents the basis of the determination;

(ii) The employer takes all feasible steps to provide maximum protection for employees until the PEL is met; and

(iii) The employer notifies the OSHA Area Director nearest the affected workplace in writing within 10 working days of the completion or revision of the compliance plan reflecting the determination.

(5) *Mechanical ventilation.* (i) When ventilation is used to control exposure, measurements which demonstrate the effectiveness of the system in controlling exposure, such as capture velocity, duct velocity, or static pressure shall be made at least every 3 months. Measurements of the system's effectiveness in controlling exposure shall be made within 5 days of any change in production, process, or control which might result in a change in employee exposure to lead.

(ii) *Recirculation of air.* If air from exhaust ventilation is recirculated into the workplace, the employer shall assure that (A) the system has a high efficiency filter with reliable back-up filter; and (B) controls to monitor the concentration of lead in the return air and to bypass the recirculation system automatically if it fails are installed, operating, and maintained.

(6) *Administrative controls.* If administrative controls are used as a means of reducing employees TWA exposure to lead, the employer shall establish and implement a job rotation schedule which includes:

(i) Name or identification number of each affected employee;

(ii) Duration and exposure levels at each job or work station where each affected employee is located; and

(iii) Any other information which may be useful in assessing the reliability of administrative controls to reduce exposure to lead.

(f) *Respiratory protection.*—(1) *General.* Where the use of respirators is required under this section, the employer shall provide, at no cost to the employee, and assure the use of respirators which comply with the requirements of this paragraph. Respirators shall be used in the following circumstances:

(i) During the time period necessary to install or implement engineering or work practice controls, except that after the dates for compliance with the interim levels in table I, no employer shall require an employee to

Occupational Safety and Health Ad

wear a negative pressure respirator longer than 4.4 hours per day;

(ii) In work situations in which engineering and work practice controls are not sufficient to reduce exposures to or below the permissible exposure limit; and

(iii) Whenever an employee requires a respirator.

(2) *Respirator selection.* (i) Where respirators are required under this section the employer shall select the appropriate respirator or combination of respirators from table II below.

TABLE II—RESPIRATORY PROTECTION FOR LEAD AEROSOLS

| Airborne concentration of lead or condition of use | Required respirator ¹ |
|--|--|
| Not in excess of 0.5 mg/m ³ (10X PEL). | Half-mask, air-purifying respirator equipped with high efficiency filters. ^{2,3} |
| Not in excess of 2.5 mg/m ³ (50X PEL). | Full facepiece, air-purifying respirator with high efficiency filters. ² |
| Not in excess of 50 mg/m ³ (1000X PEL). | (1) Any powered, air-purifying respirator with high efficiency filters; (2) Half-mask supplied-air respirator operated in positive-pressure mode. ³ |
| Not in excess of 100 mg/m ³ (2000X PEL). | Supplied-air respirators with facepiece, hood, helmet, or operated in positive pressure mode. |
| Greater than 100 mg/m ³ , unknown concentration or fire fighting. | Full facepiece, self-contained breathing apparatus operated in positive-pressure mode. |

¹ Respirators specified for high concentrations can be used at lower concentrations of lead.

² Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

³ A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron size particles.

(ii) The employer shall provide a powered, air-purifying respirator in lieu of the respirator specified in Table II whenever:

(A) An employee chooses to use that type of respirator; and

(B) This respirator will provide adequate protection to the employee.

(iii) The employer shall select respirators from among those approved for protection against lead dust, fumes, and mist by the Mine Safety and Health Administration and the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part 11.

(3) *Respirator usage.* (i) The employer shall assure that the respirator

(iii) The employer notifies the OSHA Area Director nearest the affected workplace in writing within 10 working days of the completion or revision of the compliance plan reflecting the determination.

(5) *Mechanical ventilation.* (i) When ventilation is used to control exposure, measurements which demonstrate the effectiveness of the system in controlling exposure, such as capture velocity, duct velocity, or static pressure shall be made at least every 3 months. Measurements of the system's effectiveness in controlling exposure shall be made within 5 days of any change in production, process, or control which might result in a change in employee exposure to lead.

(ii) *Recirculation of air.* If air from exhaust ventilation is recirculated into the workplace, the employer shall assure that (A) the system has a high efficiency filter with reliable back-up filter; and (B) controls to monitor the concentration of lead in the return air and to bypass the recirculation system automatically if it fails are installed, operating, and maintained.

(6) *Administrative controls.* If administrative controls are used as a means of reducing employees TWA exposure to lead, the employer shall establish and implement a job rotation schedule which includes:

(i) Name or identification number of each affected employee;

(ii) Duration and exposure levels at each job or work station where each affected employee is located; and

(iii) Any other information which may be useful in assessing the reliability of administrative controls to reduce exposure to lead.

(f) *Respiratory protection—(1) General.* Where the use of respirators is required under this section, the employer shall provide, at no cost to the employee, and assure the use of respirators which comply with the requirements of this paragraph. Respirators shall be used in the following circumstances:

(i) During the time period necessary to install or implement engineering or work practice controls, except that after the dates for compliance with the interim levels in table I, no employer shall require an employee to

wear a negative pressure respirator longer than 4.4 hours per day;

(ii) In work situations in which engineering and work practice controls are not sufficient to reduce exposures to or below the permissible exposure limit; and

(iii) Whenever an employee requests a respirator.

(2) *Respirator selection.* (i) Where respirators are required under this section the employer shall select the appropriate respirator or combination of respirators from table II below.

TABLE II—RESPIRATORY PROTECTION FOR LEAD AEROSOLS

| Airborne concentration of lead or condition of use | Required respirator ¹ |
|---|--|
| Not in excess of 0.5 mg/m ³ (10X PEL). | Half-mask, air-purifying respirator equipped with high efficiency filters. ² |
| Not in excess of 2.5 mg/m ³ (50X PEL). Not in excess of 50 mg/m ³ (1000X PEL). | Full facepiece, air-purifying respirator with high efficiency filters. ² (1) Any powered, air-purifying respirator with high efficiency filters; ³ or (2) Half-mask supplied-air respirator operated in positive-pressure mode. ³ |
| Not in excess of 100 mg/m ³ (2000X PEL). | Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive pressure mode. |
| Greater than 100 mg/m ³ unknown concentration or fire fighting. | Full facepiece, self-contained breathing apparatus operated in positive-pressure mode. |

¹Respirators specified for high concentrations can be used at lower concentrations of lead.

²Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

³A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron size particles.

(ii) The employer shall provide a powered, air-purifying respirator in lieu of the respirator specified in Table II whenever:

(A) An employee chooses to use this type of respirator; and

(B) This respirator will provide adequate protection to the employee.

(iii) The employer shall select respirators from among those approved for protection against lead dust, fume, and mist by the Mine Safety and Health Administration and the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part 11.

(3) *Respirator usage.* (i) The employer shall assure that the respirator

issued to the employee exhibits minimum facepiece leakage and that the respirator is fitted properly.

(ii) Employers shall perform either quantitative or qualitative face fit tests at the time of initial fitting and at least every six months thereafter for each employee wearing negative pressure respirators. The qualitative fit tests may be used only for testing the fit of half-mask respirators where they are permitted to be worn, and shall be conducted in accordance with Appendix D. The tests shall be used to select facepieces that provide the required protection as prescribed in table II.

(iii) If an employee exhibits difficulty in breathing during the fitting test or during use, the employer shall make available to the employee an examination in accordance with paragraph (j)(3)(i)(c) of this section to determine whether the employee can wear a respirator while performing the required duty.

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

(ii) The employer shall permit each employee who uses a filter respirator to change the filter elements whenever an increase in breathing resistance is detected and shall maintain an adequate supply of filter elements for this purpose.

(iii) Employees who wear respirators shall be permitted to leave work areas to wash their face and respirator facepiece whenever necessary to prevent skin irritation associated with respirator use.

(g) *Protective work clothing and equipment—(1) Provision and use.* If an employee is exposed to lead above the PEL, without regard to the use of respirators or where the possibility of skin or eye irritation exists, the employer shall provide at no cost to the employee and assure that the employee uses appropriate protective work clothing and equipment such as, but not limited to:

(i) Coveralls or similar full-body work clothing;

(ii) Gloves, hats, and shoes or disposable shoe coverlets; and

(iii) Face shields, vented goggles, or other appropriate protective equipment which complies with § 1910.133 of this Part.

(2) *Cleaning and replacement.* (1) The employer shall provide the protective clothing required in paragraph (g)(1) of this section in a clean and dry condition at least weekly, and daily to employees whose exposure levels without regard to a respirator are over 200 $\mu\text{g}/\text{m}^3$ of lead as an 8-hour TWA.

(ii) The employer shall provide for the cleaning, laundering, or disposal of protective clothing and equipment required by paragraph (g)(1) of this section.

(iii) The employer shall repair or replace required protective clothing and equipment as needed to maintain their effectiveness.

(iv) The employer shall assure that all protective clothing is removed at the completion of a work shift only in change rooms provided for that purpose as prescribed in paragraph (i)(2) of this section.

(v) The employer shall assure that contaminated protective clothing which is to be cleaned, laundered, or disposed of, is placed in a closed container in the change-room which prevents dispersion of lead outside the container.

(vi) The employer shall inform in writing any person who cleans or launders protective clothing or equipment of the potentially harmful effects of exposure to lead.

(vii) The employer shall assure that the containers of contaminated protective clothing and equipment required by paragraph (g)(2)(v) are labelled as follows: **CAUTION: CLOTHING CONTAMINATED WITH LEAD. DO NOT REMOVE DUST BY BLOWING OR SHAKING. DISPOSE OF LEAD CONTAMINATED WASH WATER IN ACCORDANCE WITH APPLICABLE LOCAL, STATE, OR FEDERAL REGULATIONS.**

(viii) The employer shall prohibit the removal of lead from protective clothing or equipment by blowing, shaking, or any other means which disperses lead into the air.

(h) *Housekeeping—(1) Surfaces.* All surfaces shall be maintained as free as practicable of accumulations of lead.

(2) *Cleaning floors.* (i) Floors and other surfaces where lead accumulates may not be cleaned by the use of compressed air.

(ii) Shoveling, dry or wet sweeping, and brushing may be used only where vacuuming or other equally effective methods have been tried and found not to be effective.

(3) *Vacuuuming.* Where vacuuming methods are selected, the vacuums shall be used and emptied in a manner which minimizes the reentry of lead into the workplace.

(i) *Hygiene facilities and practices.*

(1) The employer shall assure that in areas where employees are exposed to lead above the PEL, without regard to the use of respirators, food or beverage is not present or consumed, tobacco products are not present or used, and cosmetics are not applied, except in change rooms, lunchrooms, and showers required under paragraphs (i)(2)–(i)(4) of this section.

(2) *Change rooms.* (i) The employer shall provide clean change rooms for employees who work in areas where their airborne exposure to lead is above the PEL, without regard to the use of respirators.

(ii) The employer shall assure that change rooms are equipped with separate storage facilities for protective work clothing and equipment and for street clothes which prevent cross-contamination.

(3) *Showers.* (i) The employer shall assure that employees who work in areas where their airborne exposure to lead is above the PEL, without regard to the use of respirators, shower at the end of the work shift.

(ii) The employer shall provide shower facilities in accordance with § 1910.141 (d)(3) of this part.

(iii) The employer shall assure that employees who are required to shower pursuant to paragraph (i)(3)(i) do not leave the workplace wearing any clothing or equipment worn during the work shift.

(4) *Lunchrooms.* (i) The employer shall provide lunchroom facilities for employees who work in areas where their airborne exposure to lead is above the PEL, without regard to the use of respirators.

(ii) The employer shall assure that lunchroom facilities have a temperature controlled, positive pressure, filtered air supply, and are readily accessible to employees.

(iii) The employer shall assure that employees who work in areas where their airborne exposure to lead is above the PEL without regard to the use of a respirator wash their hands and face prior to eating, drinking, smoking or applying cosmetics.

(iv) The employer shall assure that employees do not enter lunchroom facilities with protective work clothing or equipment unless surface lead dust has been removed by vacuum, downdraft booth, or other clean method.

(5) *Lavatories.* The employer shall provide an adequate number of lavatory facilities which comply with § 1910.141(d) (1) and (2) of this part.

(j) *Medical surveillance—(1) General.*

(i) The employer shall institute a medical surveillance program for employees who are or may be exposed to lead above the action level for more than 30 days per year.

(ii) The employer shall assure that all medical examinations and procedures are performed by or under the supervision of a licensed physician.

(iii) The employer shall provide the required medical surveillance including multiple physician review under paragraph (j)(3)(iii) without cost to employees and at a reasonable time and place.

(2) *Biological monitoring—(1) Blood lead and ZPP level sampling and analysis.* The employer shall make available biological monitoring in the form of blood sampling and analysis for lead and zinc protoporphyrin levels for each employee covered under paragraph (j)(1)(i) of this section on the following schedule:

(A) At least every 6 months to each employee covered under paragraph (j)(1)(i) of this section;

(B) At least every two months for each employee whose last blood sampling and analysis indicated a blood lead level at or above 40 $\mu\text{g}/100\text{ g}$ whole blood. This frequency shall continue until two consecutive blood samples and analyses indicate a blood lead

(2) *Cleaning floors.* (i) Floors and other surfaces where lead accumulates may not be cleaned by the use of compressed air.

(ii) Shoveling, dry or wet sweeping, and brushing may be used only where vacuuming or other equally effective methods have been tried and found not to be effective.

(3) *Vacuuuming.* Where vacuuming methods are selected, the vacuums shall be used and emptied in a manner which minimizes the reentry of lead into the workplace.

(i) *Hygiene facilities and practices.* (1) The employer shall assure that in areas where employees are exposed to lead above the PEL, without regard to the use of respirators, food or beverage is not present or consumed, tobacco products are not present or used, and cosmetics are not applied, except in change rooms, lunchrooms, and showers required under paragraphs (i)(2)-(i)(4) of this section.

(2) *Change rooms.* (i) The employer shall provide clean change rooms for employees who work in areas where their airborne exposure to lead is above the PEL, without regard to the use of respirators.

(ii) The employer shall assure that change rooms are equipped with separate storage facilities for protective work clothing and equipment and for street clothes which prevent cross-contamination.

(3) *Showers.* (i) The employer shall assure that employees who work in areas where their airborne exposure to lead is above the PEL, without regard to the use of respirators, shower at the end of the work shift.

(ii) The employer shall provide shower facilities in accordance with § 1910.141 (d)(3) of this part.

(iii) The employer shall assure that employees who are required to shower pursuant to paragraph (i)(3)(i) do not leave the workplace wearing any clothing or equipment worn during the work shift.

(4) *Lunchrooms.* (i) The employer shall provide lunchroom facilities for employees who work in areas where their airborne exposure to lead is above the PEL, without regard to the use of respirators.

(ii) The employer shall assure that lunchroom facilities have a temperature controlled, positive pressure, filtered air supply, and are readily accessible to employees.

(iii) The employer shall assure that employees who work in areas where their airborne exposure to lead is above the PEL without regard to the use of a respirator wash their hands and face prior to eating, drinking, smoking or applying cosmetics.

(iv) The employer shall assure that employees do not enter lunchroom facilities with protective work clothing or equipment unless surface lead dust has been removed by vacuuming, downdraft booth, or other cleaning method.

(5) *Lavatories.* The employer shall provide an adequate number of lavatory facilities which comply with § 1910.141(d) (1) and (2) of this part.

(j) *Medical surveillance—(1) General.* (i) The employer shall institute a medical surveillance program for all employees who are or may be exposed above the action level for more than 30 days per year.

(ii) The employer shall assure that all medical examinations and procedures are performed by or under the supervision of a licensed physician.

(iii) The employer shall provide the required medical surveillance including multiple physician review under paragraph (j)(3)(iii) without cost to employees and at a reasonable time and place.

(2) *Biological monitoring—(1) Blood lead and ZPP level sampling and analysis.* The employer shall make available biological monitoring in the form of blood sampling and analysis for lead and zinc protoporphyrin levels to each employee covered under paragraph (j)(1)(i) of this section on the following schedule:

(A) At least every 6 months to each employee covered under paragraph (j)(1)(i) of this section;

(B) At least every two months for each employee whose last blood sampling and analysis indicated a blood lead level at or above 40 µg/100 g of whole blood. This frequency shall continue until two consecutive blood samples and analyses indicate a blood lead

level below 40 µg/100 g of whole blood; and

(C) At least monthly during the removal period of each employee removed from exposure to lead due to an elevated blood lead level.

(ii) *Follow-up blood sampling tests.* Whenever the results of a blood lead level test indicate that an employee's blood lead level exceeds the numerical criterion for medical removal under paragraph (k)(1)(i), the employer shall provide a second (follow-up) blood sampling test within two weeks after the employer receives the results of the first blood sampling test.

(iii) *Accuracy of blood lead level sampling and analysis.* Blood lead level sampling and analysis provided pursuant to this section shall have an accuracy (to a confidence level of 95 percent) within plus or minus 15 percent or 6 µg/100ml, whichever is greater, and shall be conducted by a laboratory licensed by the Center for Disease Control, United States Department of Health, Education and Welfare (CDC) or which has received a satisfactory grade in blood lead proficiency testing from CDC in the prior twelve months.

(iv) *Employee notification.* Within five working days after the receipt of biological monitoring results, the employer shall notify in writing each employee whose blood lead level exceeds 40 µg/100 g: (A) of that employee's blood lead level and (B) that the standard requires temporary medical removal with Medical Removal Protection benefits when an employee's blood lead level exceeds the numerical criterion for medical removal under paragraph (k)(1)(i) of this section.

(3) *Medical examinations and consultations—(i) Frequency.* The employer shall make available medical examinations and consultations to each employee covered under paragraph (j)(1)(i) of this section on the following schedule:

(A) At least annually for each employee for whom a blood sampling test conducted at any time during the preceding 12 months indicated a blood lead level at or above 40 µg/100 g;

(B) Prior to assignment for each employee being assigned for the first time to an area in which airborne con-

centrations of lead are at or above the action level;

(C) As soon as possible, upon notification by an employee either that the employee has developed signs or symptoms commonly associated with lead intoxication, that the employee desires medical advice concerning the effects of current or past exposure to lead on the employee's ability to procreate a healthy child, or that the employee has demonstrated difficulty in breathing during a respirator fitting test or during use; and

(D) As medically appropriate for each employee either removed from exposure to lead due to a risk of sustaining material impairment to health, or otherwise limited pursuant to a final medical determination.

(ii) *Content.* Medical examinations made available pursuant to paragraph (j)(3)(i)(A)-(B) of this section shall include the following elements:

(A) A detailed work history and a medical history, with particular attention to past lead exposure (occupational and non-occupational), personal habits (smoking, hygiene), and past gastrointestinal, hematologic, renal, cardiovascular, reproductive and neurological problems;

(B) A thorough physical examination, with particular attention to teeth, gums, hematologic, gastrointestinal, renal, cardiovascular, and neurological systems. Pulmonary status should be evaluated if respiratory protection will be used;

(C) A blood pressure measurement;

(D) A blood sample and analysis which determines:

(1) Blood lead level;

(2) Hemoglobin and hematocrit determinations, red cell indices, and examination of peripheral smear morphology;

(3) Zinc protoporphyrin;

(4) Blood urea nitrogen; and,

(5) Serum creatinine;

(E) A routine urinalysis with microscopic examination; and

(F) Any laboratory or other test which the examining physician deems necessary by sound medical practice.

The content of medical examinations made available pursuant to paragraph (j)(3)(i)(C)-(D) of this section shall be determined by an examining physician

and, if requested by an employee, shall include pregnancy testing or laboratory evaluation of male fertility.

(iii) *Multiple physician review mechanism.* (A) If the employer selects the initial physician who conducts any medical examination or consultation provided to an employee under this section, the employee may designate a second physician:

(1) To review any findings, determinations or recommendations of the initial physician; and

(2) To conduct such examinations, consultations, and laboratory tests as the second physician deems necessary to facilitate this review.

(B) The employer shall promptly notify an employee of the right to seek a second medical opinion after each occasion that an initial physician conducts a medical examination or consultation pursuant to this section. The employer may condition its participation in, and payment for, the multiple physician review mechanism upon the employee doing the following within fifteen (15) days after receipt of the foregoing notification, or receipt of the initial physician's written opinion, whichever is later:

(1) The employee informing the employer that he or she intends to seek a second medical opinion, and

(2) The employee initiating steps to make an appointment with a second physician.

(C) If the findings, determinations or recommendations of the second physician differ from those of the initial physician, then the employer and the employee shall assure that efforts are made for the two physicians to resolve any disagreement.

(D) If the two physicians have been unable to quickly resolve their disagreement, then the employer and the employee through their respective physicians shall designate a third physician:

(1) To review any findings, determinations or recommendations of the prior physicians; and

(2) To conduct such examinations, consultations, laboratory tests and discussions with the prior physicians as the third physician deems necessary to resolve the disagreement of the prior physicians.

(E) The employer shall act consistent with the findings, determinations and recommendations of the two physicians, unless the employer and the employee reach an agreement which is otherwise consistent with recommendations of at least one of the three physicians.

(iv) *Information provided to examining and consulting physicians.* (A) The employer shall provide an initial physician conducting a medical examination or consultation under this section with the following information:

(1) A copy of this regulation for lead including all Appendices;

(2) A description of the affected employee's duties as they relate to the employee's exposure;

(3) The employee's exposure level anticipated exposure level to lead to any other toxic substance (if applicable);

(4) A description of any personal protective equipment used or to be used;

(5) Prior blood lead determinations and

(6) All prior written medical opinions concerning the employee in the employer's possession or control.

(B) The employer shall provide the foregoing information to a second or third physician conducting a medical examination or consultation under this section upon request either by the second or third physician, or by the employee.

(v) *Written medical opinions.* (A) The employer shall obtain and furnish the employee with a copy of a written medical opinion from each examining or consulting physician which contains the following information:

(1) The physician's opinion as to whether the employee has any detected medical condition which would place the employee at increased risk of material impairment of the employee's health from exposure to lead;

(2) Any recommended special protective measures to be provided to the employee, or limitations to be placed upon the employee's exposure to lead;

(3) Any recommended limitations upon the employee's use of respirators, including a determination of whether the employee can wear a powered or purifying respirator if a physi-

and, if requested by an employee, shall include pregnancy testing or laboratory evaluation of male fertility.

(iii) *Multiple physician review mechanism.* (A) If the employer selects the initial physician who conducts any medical examination or consultation provided to an employee under this section, the employee may designate a second physician:

(1) To review any findings, determinations or recommendations of the initial physician; and

(2) To conduct such examinations, consultations, and laboratory tests as the second physician deems necessary to facilitate this review.

(B) The employer shall promptly notify an employee of the right to seek a second medical opinion after each occasion that an initial physician conducts a medical examination or consultation pursuant to this section. The employer may condition its participation in, and payment for, the multiple physician review mechanism upon the employee doing the following within fifteen (15) days after receipt of the foregoing notification, or receipt of the initial physician's written opinion, whichever is later:

(1) The employee informing the employer that he or she intends to seek a second medical opinion, and

(2) The employee initiating steps to make an appointment with a second physician.

(C) If the findings, determinations or recommendations of the second physician differ from those of the initial physician, then the employer and the employee shall assure that efforts are made for the two physicians to resolve any disagreement.

(D) If the two physicians have been unable to quickly resolve their disagreement, then the employer and the employee through their respective physicians shall designate a third physician:

(1) To review any findings, determinations or recommendations of the prior physicians; and

(2) To conduct such examinations, consultations, laboratory tests and discussions with the prior physicians as the third physician deems necessary to resolve the disagreement of the prior physicians.

(E) The employer shall act consistently with the findings, determinations and recommendations of the third physician, unless the employer and the employee reach an agreement which is otherwise consistent with the recommendations of at least one of the three physicians.

(iv) *Information provided to examining and consulting physicians.* (A) The employer shall provide an initial physician conducting a medical examination or consultation under this section with the following information:

(1) A copy of this regulation for lead including all Appendices;

(2) A description of the affected employee's duties as they relate to the employee's exposure;

(3) The employee's exposure level or anticipated exposure level to lead and to any other toxic substance (if applicable);

(4) A description of any personal protective equipment used or to be used;

(5) Prior blood lead determinations; and

(6) All prior written medical opinions concerning the employee in the employer's possession or control.

(B) The employer shall provide the foregoing information to a second or third physician conducting a medical examination or consultation under this section upon request either by the second or third physician, or by the employee.

(v) *Written medical opinions.* (A) The employer shall obtain and furnish the employee with a copy of a written medical opinion from each examining or consulting physician which contains the following information:

(1) The physician's opinion as to whether the employee has any detected medical condition which would place the employee at increased risk of material impairment of the employee's health from exposure to lead;

(2) Any recommended special protective measures to be provided to the employee, or limitations to be placed upon the employee's exposure to lead;

(3) Any recommended limitation upon the employee's use of respirators, including a determination of whether the employee can wear a powered air purifying respirator if a physi-

cian determines that the employee cannot wear a negative pressure respirator; and

(4) The results of the blood lead determinations.

(B) The employer shall instruct each examining and consulting physician to:

(1) Not reveal either in the written opinion, or in any other means of communication with the employer, findings, including laboratory results, or diagnoses unrelated to an employee's occupational exposure to lead; and

(2) Advise the employee of any medical condition, occupational or nonoccupational, which dictates further medical examination or treatment.

(vi) *Alternate Physician Determination Mechanisms.* The employer and an employee or authorized employee representative may agree upon the use of any expeditious alternate physician determination mechanism in lieu of the multiple physician review mechanism provided by this paragraph so long as the alternate mechanism otherwise satisfies the requirements contained in this paragraph.

(4) *Chelation.* (i) The employer shall assure that any person whom he retains, employs, supervises or controls does not engage in prophylactic chelation of any employee at any time.

(ii) If therapeutic or diagnostic chelation is to be performed by any person in paragraph (j)(4)(i), the employer shall assure that it be done under the supervision of a licensed physician in a clinical setting with thorough and appropriate medical monitoring and that the employee is notified in writing prior to its occurrence.

(k) *Medical Removal Protection—(1) Temporary medical removal and return of an employee—(i) Temporary removal due to elevated blood lead levels—(A) First year of the standard.* During the first year following the effective date of the standard, the employer shall remove an employee from work having a daily eight hour TWA exposure to lead at or above 100 $\mu\text{g}/\text{m}^3$ on each occasion that a periodic and a follow-up blood sampling test conducted pursuant to this section indicate that the employee's blood lead level is at or above 80 $\mu\text{g}/100\text{ g}$ of whole blood;

(B) *Second year of the standard.* During the second year following the effective date of the standard, the employer shall remove an employee from work having a daily 8-hour TWA exposure to lead at or above $50 \mu\text{g}/\text{m}^3$ on each occasion that a periodic and a follow-up blood sampling test conducted pursuant to this section indicate that the employee's blood lead level is at or above $70 \mu\text{g}/100 \text{ g}$ of whole blood;

(C) *Third year of the standard, and thereafter.* Beginning with the third year following the effective date of the standard, the employer shall remove an employee from work having an exposure to lead at or above the action level on each occasion that a periodic and a follow-up blood sampling test conducted pursuant to this section indicate that the employee's blood lead level is at or above $60 \mu\text{g}/100 \text{ g}$ of whole blood; and,

(D) *Fifth year of the standard, and thereafter.* Beginning with the fifth year following the effective date of the standard, the employer shall remove an employee from work having an exposure to lead at or above the action level on each occasion that the average of the last three blood sampling tests conducted pursuant to this section (or the average of all blood sampling tests conducted over the previous six (6) months, whichever is longer) indicates that the employee's blood lead level is at or above $50 \mu\text{g}/100 \text{ g}$ of whole blood; provided, however, that an employee need not be removed if the last blood sampling test indicates a blood lead level at or below $40 \mu\text{g}/100 \text{ g}$ of whole blood.

(ii) *Temporary removal due to a final medical determination.* (A) The employer shall remove an employee from work having an exposure to lead at or above the action level on each occasion that a final medical determination results in a medical finding, determination, or opinion that the employee has a detected medical condition which places the employee at increased risk of material impairment to health from exposure to lead.

(B) For the purposes of this section, the phrase "final medical determination" shall mean the outcome of the multiple physician review mechanism or alternate medical determination

mechanism used pursuant to the medical surveillance provisions of this section.

(C) Where a final medical determination results in any recommended special protective measures for an employee, or limitations on an employee's exposure to lead, the employer shall implement and act consistent with the recommendation.

(iii) *Return of the employee to former job status.* (A) The employer shall return an employee to his or her former job status:

(1) For an employee removed due to a blood lead level at or above $80 \mu\text{g}/100 \text{ g}$, when two consecutive blood sampling tests indicate that the employee's blood lead level is at or below $60 \mu\text{g}/100 \text{ g}$ of whole blood;

(2) For an employee removed due to a blood lead level at or above $70 \mu\text{g}/100 \text{ g}$, when two consecutive blood sampling tests indicate that the employee's blood lead level is at or below $50 \mu\text{g}/100 \text{ g}$ of whole blood;

(3) For an employee removed due to a blood lead level at or above $60 \mu\text{g}/100 \text{ g}$, or due to an average blood lead level at or above $50 \mu\text{g}/100 \text{ g}$, when two consecutive blood sampling tests indicate that the employee's blood lead level is at or below $40 \mu\text{g}/100 \text{ g}$ of whole blood;

(4) For an employee removed due to a final medical determination, when a subsequent final medical determination results in a medical finding, determination, or opinion that the employee no longer has a detected medical condition which places the employee at increased risk of material impairment to health from exposure to lead.

(B) For the purposes of this section, the requirement that an employer return an employee to his or her former job status is not intended to expand upon or restrict any rights an employee has or would have had, absent temporary medical removal, to a specific job classification or position under the terms of a collective bargaining agreement.

(iv) *Removal of other employee special protective measure or limitations.* The employer shall remove any limitations placed on an employee or end any special protective measures provided to an employee pursuant to a

Occupational Safety and Health

final medical determination where subsequent final medical determination indicates that the limitation special protective measures are no longer necessary.

(v) *Employer options pending a medical determination.* Where multiple physician review mechanism or alternate medical determination mechanism used pursuant to the medical surveillance provisions of this section, has not yet resulted in a final medical determination with respect to an employee, the employer shall act as follows:

(A) *Removal.* The employer shall remove the employee from exposure to lead, provide special protective measures to the employee, or place limitations upon the employee, consistent with the medical findings, terminations, or recommendations of any of the physicians who have reviewed the employee's health status.

(B) *Return.* The employer shall return the employee to his or her former job status, end any special protective measures provided to the employee, and remove any limitations placed upon the employee, consistent with the medical findings, determinations, or recommendations of any of the physicians who have reviewed the employee's health status, with two exceptions. If (1) the initial removal, special protection, or limitation of the employee resulted from a final medical determination which differed from the findings, determinations, or recommendations of the initial physician or

(2) The employee has been on removal status for the preceding eighteen months due to an elevated blood lead level, then the employer shall await a final medical determination.

(2) *Medical removal protection benefits.* (i) *Provision of medical removal protection benefits.* The employer shall provide to an employee up to eighteen (18) months of medical removal protection benefits on each occasion that an employee is removed from exposure to lead or otherwise limited pursuant to this section.

(ii) *Definition of medical removal protection benefits.* For the purposes of this section, the requirement that an employer provide medical removal

mechanism used pursuant to the medical surveillance provisions of this section.

(C) Where a final medical determination results in any recommended special protective measures for an employee, or limitations on an employee's exposure to lead, the employer shall implement and act consistent with the recommendation.

(iii) *Return of the employee to former job status.* (A) The employer shall return an employee to his or her former job status:

(1) For an employee removed due to a blood lead level at or above 80 $\mu\text{g}/100$ g, when two consecutive blood sampling tests indicate that the employee's blood lead level is at or below 60 $\mu\text{g}/100$ g of whole blood;

(2) For an employee removed due to a blood lead level at or above 70 $\mu\text{g}/100$ g, when two consecutive blood sampling tests indicate that the employee's blood lead level is at or below 50 $\mu\text{g}/100$ g of whole blood;

(3) For an employee removed due to a blood lead level at or above 60 $\mu\text{g}/100$ g, or due to an average blood lead level at or above 50 $\mu\text{g}/100$ g, when two consecutive blood sampling tests indicate that the employee's blood lead level is at or below 40 $\mu\text{g}/100$ g of whole blood;

(4) For an employee removed due to a final medical determination, when a subsequent final medical determination results in a medical finding, determination, or opinion that the employee no longer has a detected medical condition which places the employee at increased risk of material impairment to health from exposure to lead.

(B) For the purposes of this section, the requirement that an employer return an employee to his or her former job status is not intended to expand upon or restrict any rights an employee has or would have had absent temporary medical removal to a specific job classification or position under the terms of a collective bargaining agreement.

(iv) *Removal of other employee special protective measure or limitations.* The employer shall remove any limitations placed on an employee or end any special protective measures provided to an employee pursuant to a

final medical determination when a subsequent final medical determination indicates that the limitations or special protective measures are no longer necessary.

(v) *Employer options pending a final medical determination.* Where the multiple physician review mechanism, or alternate medical determination mechanism used pursuant to the medical surveillance provisions of this section has not yet resulted in a final medical determination with respect to an employee, the employer shall act as follows:

(A) *Removal.* The employer may remove the employee from exposure to lead, provide special protective measures to the employee, or place limitations upon the employee, consistent with the medical findings, determinations, or recommendations of any of the physicians who have reviewed the employee's health status.

(B) *Return.* The employer may return the employee to his or her former job status, end any special protective measures provided to the employee, and remove any limitations placed upon the employee, consistent with the medical findings, determinations, or recommendations of any of the physicians who have reviewed the employee's health status, with two exceptions. If (1) the initial removal, special protection, or limitation of the employee resulted from a final medical determination which differed from the findings, determinations, or recommendations of the initial physician or

(2) The employee has been on removal status for the preceding eighteen months due to an elevated blood lead level, then the employer shall await a final medical determination.

(C) *Medical removal protection benefits.* (1) *Provision of medical removal protection benefits.* The employer shall provide to an employee up to eighteen (18) months of medical removal protection benefits on each occasion that an employee is removed from exposure to lead or otherwise removed pursuant to this section.

(2) *Definition of medical removal protection benefits.* For the purposes of this section, the requirement that an employer provide medical removal

protection benefits means that the employer shall maintain the earnings, seniority and other employment rights and benefits of an employee as though the employee had not been removed from normal exposure to lead or otherwise limited.

(iii) *Follow-up medical surveillance during the period of employee removal or limitation.* During the period of time that an employee is removed from normal exposure to lead or otherwise limited, the employer may condition the provision of medical removal protection benefits upon the employee's participation in follow-up medical surveillance made available pursuant to this section.

(iv) *Workers' compensation claims.* If a removed employee files a claim for workers' compensation payments for a lead-related disability, then the employer shall continue to provide medical removal protection benefits pending disposition of the claim. To the extent that an award is made to the employee for earnings lost during the period of removal, the employer's medical removal protection obligation shall be reduced by such amount. The employer shall receive no credit for workers' compensation payments received by the employee for treatment related expenses.

(v) *Other credits.* The employer's obligation to provide medical removal protection benefits to a removed employee shall be reduced to the extent that the employee receives compensation for earnings lost during the period of removal either from a publicly or employer-funded compensation program, or receives income from employment with another employer made possible by virtue of the employee's removal.

(vi) *Employees whose blood lead levels do not adequately decline within 18 months of removal.* The employer shall take the following measures with respect to any employee removed from exposure to lead due to an elevated blood lead level whose blood lead level has not declined within the past eighteen (18) months of removal so that the employee has been returned to his or her former job status:

(A) The employer shall make available to the employee a medical exami-

nation pursuant to this section to obtain a final medical determination with respect to the employee;

(B) The employer shall assure that the final medical determination obtained indicates whether or not the employee may be returned to his or her former job status, and if not, what steps should be taken to protect the employee's health;

(C) Where the final medical determination has not yet been obtained, or once obtained indicates that the employee may not yet be returned to his or her former job status, the employer shall continue to provide medical removal protection benefits to the employee until either the employee is returned to former job status, or a final medical determination is made that the employee is incapable of ever safely returning to his or her former job status.

(D) Where the employer acts pursuant to a final medical determination which permits the return of the employee to his or her former job status despite what would otherwise be an unacceptable blood lead level, later questions concerning removing the employee again shall be decided by a final medical determination. The employer need not automatically remove such an employee pursuant to the blood lead level removal criteria provided by this section.

(vii) *Voluntary Removal or Restriction of An Employee.* Where an employer, although not required by this section to do so, removes an employee from exposure to lead or otherwise places limitations on an employee due to the effects of lead exposure on the employee's medical condition, the employer shall provide medical removal protection benefits to the employee equal to that required by paragraph (k)(2)(i) of this section.

(1) *Employee information and training—(1) Training program.* (i) Each employer who has a workplace in which there is a potential exposure to airborne lead at any level shall inform employees of the content of Appendices A and B of this regulation.

(ii) The employer shall institute a training program for and assure the participation of all employees who are subject to exposure to lead at or above

the action level or for whom the possibility of skin or eye irritation exists.

(iii) The employer shall provide initial training by 180 days from the effective date for those employees covered by paragraph (1)(1)(ii) on the standard's effective date and prior to the time of initial job assignment for those employees subsequently covered by this paragraph.

(iv) The training program shall be repeated at least annually for each employee.

(v) The employer shall assure that each employee is informed of the following:

(A) The content of this standard and its appendices;

(B) The specific nature of the operations which could result in exposure to lead above the action level;

(C) The purpose, proper selection, fitting, use, and limitations of respirators;

(D) The purpose and a description of the medical surveillance program, and the medical removal protection program including information concerning the adverse health effects associated with excessive exposure to lead (with particular attention to the adverse reproductive effects on both males and females);

(E) The engineering controls and work practices associated with the employee's job assignment;

(F) The contents of any compliance plan in effect; and

(G) Instructions to employees that chelating agents should not routinely be used to remove lead from their bodies and should not be used at all except under the direction of a licensed physician;

(2) *Access to information and training materials.* (i) The employer shall make readily available to all affected employees a copy of this standard and its appendices.

(ii) The employer shall provide, upon request, all materials relating to the employee information and training program to the Assistant Secretary and the Director.

(iii) In addition to the information required by paragraph (1)(1)(v), the employer shall include as part of the training program, and shall distribute to employees, any materials pertaining

Occupational Safety and Health

to the Occupational Safety and Health Act, the regulations issued pursuant to that Act, and this lead standard which are made available to the employer by the Assistant Secretary.

(m) *Signs—(1) General.* (i) The employer may use signs required by other statutes, regulations or ordinance in addition to, or in combination with signs required by this paragraph.

(ii) The employer shall assure that no statement appears on or near a sign required by this paragraph which contradicts or detracts from the meaning of the required sign.

(2) *Signs.* (i) The employer shall post the following warning signs in each work area where the PEL is exceeded:

WARNING

LEAD WORK AREA

POISON

NO SMOKING OR EATING

(ii) The employer shall assure that signs required by this paragraph are illuminated and cleaned as necessary so that the legend is readily visible.

(n) *Recordkeeping—(1) Exposure monitoring.* (i) The employer shall establish and maintain an accurate record of all monitoring required by paragraph (d) of this section.

(ii) This record shall include:

(A) The date(s), number, duration, location and results of each of the samples taken, including a description of the sampling procedure used to determine representative employee exposure where applicable;

(B) A description of the sampling and analytical methods used and evidence of their accuracy;

(C) The type of respiratory protective devices worn, if any;

(D) Name, social security number and job classification of the employee monitored and of all other employees whose exposure the measurement is intended to represent; and

(E) The environmental variables that could affect the measurement of employee exposure.

(iii) The employer shall maintain these monitoring records for at least 40 years or for the duration of employment plus 20 years, whichever is longer.

the action level or for whom the possibility of skin or eye irritation exists.

(iii) The employer shall provide initial training by 180 days from the effective date for those employees covered by paragraph (l)(1)(ii) on the standard's effective date and prior to the time of initial job assignment for those employees subsequently covered by this paragraph.

(iv) The training program shall be repeated at least annually for each employee.

(v) The employer shall assure that each employee is informed of the following:

(A) The content of this standard and its appendices;

(B) The specific nature of the operations which could result in exposure to lead above the action level;

(C) The purpose, proper selection, fitting, use, and limitations of respirators;

(D) The purpose and a description of the medical surveillance program, and the medical removal protection program including information concerning the adverse health effects associated with excessive exposure to lead (with particular attention to the adverse reproductive effects on both males and females);

(E) The engineering controls and work practices associated with the employee's job assignment;

(F) The contents of any compliance plan in effect; and

(G) Instructions to employees that chelating agents should not routinely be used to remove lead from their bodies and should not be used at all except under the direction of a licensed physician;

(2) *Access to information and training materials.* (i) The employer shall make readily available to all affected employees a copy of this standard and its appendices.

(ii) The employer shall provide, upon request, all materials relating to the employee information and training program to the Assistant Secretary and the Director.

(iii) In addition to the information required by paragraph (l)(1)(v), the employer shall include as part of the training program, and shall distribute to employees, any materials pertaining

to the Occupational Safety and Health Act, the regulations issued pursuant to that Act, and this lead standard, which are made available to the employer by the Assistant Secretary.

(m) *Signs*—(1) *General.* (i) The employer may use signs required by other statutes, regulations or ordinances in addition to, or in combination with, signs required by this paragraph.

(ii) The employer shall assure that no statement appears on or near any sign required by this paragraph which contradicts or detracts from the meaning of the required sign.

(2) *Signs.* (i) The employer shall post the following warning signs in each work area where the PEL is exceeded:

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NO SMOKING OR EATING

(ii) The employer shall assure that signs required by this paragraph are illuminated and cleaned as necessary so that the legend is readily visible.

(n) *Recordkeeping*—(1) *Exposure monitoring.* (i) The employer shall establish and maintain an accurate record of all monitoring required in paragraph (d) of this section.

(ii) This record shall include:

(A) The date(s), number, duration, location and results of each of the samples taken, including a description of the sampling procedure used to determine representative employee exposure where applicable;

(B) A description of the sampling and analytical methods used and evidence of their accuracy;

(C) The type of respiratory protective devices worn, if any;

(D) Name, social security number, and job classification of the employee monitored and of all other employees whose exposure the measurement is intended to represent; and

(E) The environmental variables that could affect the measurement of employee exposure.

(iii) The employer shall maintain these monitoring records for at least 40 years or for the duration of employment plus 20 years, whichever is longer.

(2) *Medical surveillance.* (i) The employer shall establish and maintain an accurate record for each employee subject to medical surveillance as required by paragraph (j) of this section.

(ii) This record shall include:

(A) The name, social security number, and description of the duties of the employee;

(B) A copy of the physician's written opinions;

(C) Results of any airborne exposure monitoring done for that employee and the representative exposure levels supplied to the physician; and

(D) Any employee medical complaints related to exposure to lead.

(iii) The employer shall keep, or assure that the examining physician keeps, the following medical records:

(A) A copy of the medical examination results including medical and work history required under paragraph (j) of this section;

(B) A description of the laboratory procedures and a copy of any standards or guidelines used to interpret the test results or references to that information;

(C) A copy of the results of biological monitoring.

(iv) The employer shall maintain or assure that the physician maintains those medical records for at least 40 years, or for the duration of employment plus 20 years, whichever is longer.

(3) *Medical removals.* (i) The employer shall establish and maintain an accurate record for each employee removed from current exposure to lead pursuant to paragraph (k) of this section.

(ii) Each record shall include:

(A) The name and social security number of the employee;

(B) The date on each occasion that the employee was removed from current exposure to lead as well as the corresponding date on which the employee was returned to his or her former job status;

(C) A brief explanation of how each removal was or is being accomplished; and

(D) A statement with respect to each removal indicating whether or not the reason for the removal was an elevated blood lead level.

(iii) The employer shall maintain each medical removal record for at least the duration of an employee's employment.

(4) *Availability.* (i) The employer shall make available upon request all records required to be maintained by paragraph (n) of this section to the Assistant Secretary and the Director for examination and copying.

(ii) Environmental monitoring, medical removal, and medical records required by this paragraph shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20 (a)-(e) and (2)-(i). Medical removal records shall be provided in the same manner as environmental monitoring records.

(5) *Transfer of records.* (i) Whenever the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by paragraph (n) of this section.

(ii) Whenever the employer ceases to do business and there is no successor employer to receive and retain the records required to be maintained by this section for the prescribed period, these records shall be transmitted to the Director.

(iii) At the expiration of the retention period for the records required to be maintained by this section, the employer shall notify the Director at least 3 months prior to the disposal of such records and shall transmit those records to the Director if requested within the period.

(iv) The employer shall also comply with any additional requirements involving transfer of records set forth in 29 CFR 1910.20(h).

(o) *Observation of monitoring.* (1) *Employee observation.* The employer shall provide affected employees or their designated representatives an opportunity to observe any monitoring of employee exposure to lead conducted pursuant to paragraph (d) of this section.

(2) *Observation procedures.* (i) Whenever observation of the monitoring of employee exposure to lead requires entry into an area where the use of respirators, protective clothing or equipment is required, the employ-

er shall provide the observer with and assure the use of such respirators, clothing and such equipment, and shall require the observer to comply with all other applicable safety and health procedures.

(ii) Without interfering with the monitoring, observers shall be entitled to:

(A) Receive an explanation of the measurement procedures;

(B) Observe all steps related to the monitoring of lead performed at the place of exposure; and

(C) Record the results obtained or receive copies of the results when returned by the laboratory.

(p) *Effective date.* This standard shall become effective March 1, 1979.

(q) *Appendices.* The information contained in the appendices to this section is not intended by itself, to create any additional obligations not otherwise imposed by this standard nor detract from any existing obligation.

(r) *Startup dates.* All obligations of this standard commence on the effective date except as follows:

(1) The initial determination under paragraph (d)(2) shall be made as soon as possible but no later than 30 days from the effective date.

(2) Initial monitoring under paragraph (d)(4) shall be completed as soon as possible but no later than 90 days from the effective date.

(3) Initial biological monitoring and medical examinations under paragraph (j) shall be completed as soon as possible but no later than 180 days from the effective date. Priority for biological monitoring and medical examinations shall be given to employees whom the employer believes to be at greatest risk from continued exposure.

(4) Initial training and education shall be completed as soon as possible but no later than 180 days from the effective date.

(5) Hygiene and lunchroom facilities under paragraph (i) shall be in operation as soon as possible but no later than 1 year from the effective year.

(6)(i) Respiratory protection required by paragraph (f) shall be provided as soon as possible but no later than the following schedule:

Occupational Safety and Health A

(A) Employees whose 8-hour exposure exceeds 200 $\mu\text{g}/\text{m}^3$ —on effective date.

(B) Employees whose 8-hour exposure exceeds the PEL but is not later than 200 $\mu\text{g}/\text{m}^3$ —150 days from the effective date.

(C) Powered, air-purifying respirators required under (f)(2)(ii)—210 days from the effective date.

(D) Quantitative fit testing required under (f)(3)(ii)—one year from effective date. Qualitative fit testing is required the interim.

(7)(i) Written compliance plans required by paragraph (e)(3) shall be completed and available for inspection and copying as soon as possible but later than the following schedule:

(A) Employers for whom compliance with the PEL or interim level is required will year from the effective date—6 months from the effective date.

(B) Employers in secondary smelting, refining, lead storage battery manufacturing, lead pigment manufacturing and nonferrous foundry industries—1 year from the effective date.

(C) Employers in primary smelting and refining industry—1 year from the effective date for the interim level; 5 years from the effective date for PEL.

(D) Plans for construction of hygiene facilities, if required—6 months from the effective date.

(8) The permissible exposure limit under paragraph (c) shall become effective 150 days from the effective date.

APPENDIX A TO SECTION 1910.1025—SUBSTANCE DATA SHEET FOR OCCUPATIONAL EXPOSURE TO LEAD

I. SUBSTANCE IDENTIFICATION

A. *Substance:* Pure lead (Pb), a heavy metal at room temperature and pressure and is a basic chemical element. It can combine with various other substances to form numerous lead compounds.

B. *Compounds Covered by the Standard:* The word "lead" when used in the standard means elemental lead, all inorganic lead compounds and a class of organic lead compounds called lead soaps. This standard does not apply to other organic lead compounds.

C. *Uses:* Exposure to lead occurs in at least 120 different occupations, including primary and secondary lead smelting, lead storage battery manufacturing, lead pigment manufacturing and use, solder manufacturing and use, shipbuilding and ship repairing, auto manufacturing, and printing.

er shall provide the observer with and assure the use of such respirators, clothing and such equipment, and shall require the observer to comply with all other applicable safety and health procedures.

(ii) Without interfering with the monitoring, observers shall be entitled to:

(A) Receive an explanation of the measurement procedures;

(B) Observe all steps related to the monitoring of lead performed at the place of exposure; and

(C) Record the results obtained or receive copies of the results when returned by the laboratory.

(p) *Effective date.* This standard shall become effective March 1, 1979.

(q) *Appendices.* The information contained in the appendices to this section is not intended by itself, to create any additional obligations not otherwise imposed by this standard nor detract from any existing obligation.

(r) *Startup dates.* All obligations of this standard commence on the effective date except as follows:

(1) The initial determination under paragraph (d)(2) shall be made as soon as possible but no later than 30 days from the effective date.

(2) Initial monitoring under paragraph (d)(4) shall be completed as soon as possible but no later than 90 days from the effective date.

(3) Initial biological monitoring and medical examinations under paragraph (j) shall be completed as soon as possible but no later than 180 days from the effective date. Priority for biological monitoring and medical examinations shall be given to employees whom the employer believes to be at greatest risk from continued exposure.

(4) Initial training and education shall be completed as soon as possible but no later than 180 days from the effective date.

(5) Hygiene and lunchroom facilities under paragraph (l) shall be in operation as soon as possible but no later than 1 year from the effective year.

(6)(i) Respiratory protection required by paragraph (f) shall be provided as soon as possible but no later than the following schedule:

(A) Employees whose 8-hour TWA exposure exceeds $200 \mu\text{g}/\text{m}^3$ —on the effective date.

(B) Employees whose 8-hour TWA exposure exceeds the PEL but is less than $200 \mu\text{g}/\text{m}^3$ —150 days from the effective date.

(C) Powered, air-purifying respirators provided under (f)(2)(ii)—210 days from the effective date.

(D) Quantitative fit testing required under (f)(3)(ii)—one year from effective date. Qualitative fit testing is required in the interim.

(7)(i) Written compliance plans required by paragraph (e)(3) shall be completed and available for inspection and copying as soon as possible but no later than the following schedule:

(A) Employers for whom compliance with the PEL or interim level is required within 1 year from the effective date—6 months from the effective date.

(B) Employers in secondary smelting and refining, lead storage battery manufacturing, lead pigment manufacturing and nonferrous foundry industries—1 year from the effective date.

(C) Employers in primary smelting and refining industry—1 year from the effective date for the interim level; 5 years from the effective date for PEL.

(D) Plans for construction of hygiene facilities, if required—6 months from the effective date.

(8) The permissible exposure limit in paragraph (c) shall become effective 150 days from the effective date.

APPENDIX A TO SECTION 1910.1025—SUBSTANCE DATA SHEET FOR OCCUPATIONAL EXPOSURE TO LEAD

I. SUBSTANCE IDENTIFICATION

A. *Substance:* Pure lead (Pb) is a heavy metal at room temperature and pressure and is a basic chemical element. It can combine with various other substances to form numerous lead compounds.

B. *Compounds Covered by the Standard:* The word "lead" when used in this standard means elemental lead, all inorganic lead compounds and a class of organic lead compounds called lead soaps. This standard does not apply to other organic lead compounds.

C. *Uses:* Exposure to lead occurs in at least 120 different occupations, including primary and secondary lead smelting, lead storage battery manufacturing, lead pigment manufacturing and use, solder manufacturing and use, shipbuilding and ship repairing, auto manufacturing, and printing.

D. *Permissible Exposure:* The Permissible Exposure Limit (PEL) set by the standard is 50 micrograms of lead per cubic meter of air ($50 \mu\text{g}/\text{m}^3$), averaged over an 8-hour work-day.

E. *Action Level:* The standard establishes an action level of 30 micrograms per cubic meter of air ($30 \mu\text{g}/\text{m}^3$), time weighted average, based on an 8-hour work-day. The action level initiates several requirements of the standard, such as exposure monitoring, medical surveillance, and training and education.

II. HEALTH HAZARD DATA

A. *Ways in which lead enters your body.* When absorbed into your body in certain doses lead is a toxic substance. The object of the lead standard is to prevent absorption of harmful quantities of lead. The standard is intended to protect you not only from the immediate toxic effects of lead, but also from the serious toxic effects that may not become apparent until years of exposure have passed.

Lead can be absorbed into your body by inhalation (breathing) and ingestion (eating). Lead (except for certain organic lead compounds not covered by the standard, such as tetraethyl lead) is not absorbed through your skin. When lead is scattered in the air as a dust, fume or mist it can be inhaled and absorbed through your lungs and upper respiratory tract. Inhalation of airborne lead is generally the most important source of occupational lead absorption. You can also absorb lead through your digestive system if lead gets into your mouth and is swallowed. If you handle food, cigarettes, chewing tobacco, or make-up which have lead on them or handle them with hands contaminated with lead, this will contribute to ingestion.

A significant portion of the lead that you inhale or ingest gets into your blood stream. Once in your blood stream, lead is circulated throughout your body and stored in various organs and body tissues. Some of this lead is quickly filtered out of your body and excreted, but some remains in the blood and other tissues. As exposure to lead continues, the amount stored in your body will increase if you are absorbing more lead than your body is excreting. Even though you may not be aware of any immediate symptoms of disease, this lead stored in your tissues can be slowly causing irreversible damage, first to individual cells, then to your organs and whole body systems.

B. *Effects of overexposure to lead—(1) Short term (acute) overexposure.* Lead is a potent, systemic poison that serves no known useful function once absorbed by your body. Taken in large enough doses, lead can kill you in a matter of days. A condition affecting the brain called acute encephalopathy can occur.

phalopathy may arise which develops quickly to seizures, coma, and death from cardio-respiratory arrest. A short term dose of lead can lead to acute encephalopathy. Short term occupational exposures of this magnitude are highly unusual, but not impossible. Similar forms of encephalopathy may, however, arise from extended, chronic exposure to lower doses of lead. There is no sharp dividing line between rapidly developing acute effects of lead, and chronic effects which take longer to acquire. Lead adversely affects numerous body systems, and causes forms of health impairment and disease which arise after periods of exposure as short as days or as long as several years.

(2) *Long-term (chronic) overexposure.* Chronic overexposure to lead may result in severe damage to your blood-forming, nervous, urinary and reproductive systems. Some common symptoms of chronic overexposure include loss of appetite, metallic taste in the mouth, anxiety, constipation, nausea, pallor, excessive tiredness, weakness, insomnia, headache, nervous irritability, muscle and joint pain or soreness, fine tremors, numbness, dizziness, hyperactivity and colic. In lead colic there may be severe abdominal pain.

Damage to the central nervous system in general and the brain (encephalopathy) in particular is one of the most severe forms of lead poisoning. The most severe, often fatal, form of encephalopathy may be preceded by vomiting, a feeling of dullness progressing to drowsiness and stupor, poor memory, restlessness, irritability, tremor, and convulsions. It may arise suddenly with the onset of seizures, followed by coma, and death. There is a tendency for muscular weakness to develop at the same time. This weakness may progress to paralysis often observed as a characteristic "wrist drop" or "foot drop" and is a manifestation of a disease to the nervous system called peripheral neuropathy.

Chronic overexposure to lead also results in kidney disease with few, if any, symptoms appearing until extensive and most likely permanent kidney damage has occurred. Routine laboratory tests reveal the presence of this kidney disease only after about two-thirds of kidney function is lost. When overt symptoms of urinary dysfunction arise, it is often too late to correct or prevent worsening conditions, and progression to kidney dialysis or death is possible.

Chronic overexposure to lead impairs the reproductive systems of both men and women. Overexposure to lead may result in decreased sex drive, impotence and sterility in men. Lead can alter the structure of sperm cells raising the risk of birth defects. There is evidence of miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves. Lead exposure also may result

in decreased fertility, and abnormal menstrual cycles in women. The course of pregnancy may be adversely affected by exposure to lead since lead crosses the placental barrier and poses risks to developing fetuses. Children born of parents either one of whom were exposed to excess lead levels are more likely to have birth defects, mental retardation, behavioral disorders or die during the first year of childhood.

Overexposure to lead also disrupts the blood-forming system resulting in decreased hemoglobin (the substance in the blood that carries oxygen to the cells) and ultimately anemia. Anemia is characterized by weakness, pallor and fatigability as a result of decreased oxygen carrying capacity in the blood.

(3) *Health protection goals of the standard.* Prevention of adverse health effects for most workers from exposure to lead throughout a working lifetime requires that worker blood lead (PbB) levels be maintained at or below forty micrograms per one hundred grams of whole blood (40 $\mu\text{g}/100\text{g}$). The blood lead levels of workers (both male and female workers) who intend to have children should be maintained below 30 $\mu\text{g}/100\text{g}$ to minimize adverse reproductive health effects to the parents and to the developing fetus.

The measurement of your blood lead level is the most useful indicator of the amount of lead being absorbed by your body. Blood lead levels (PbB) are most often reported in units of milligrams (mg) or micrograms (μg) of lead (1 mg=1000 μg) per 100 grams (100g), 100 milliliters (100 ml) or deciliter (dl) of blood. These three units are essentially the same. Sometime PbB's are expressed in the form of mg% or $\mu\text{g}\%$. This is a shorthand notation for 100g, 100 ml, or dl.

PbB measurements show the amount of lead circulating in your blood stream, but do not give any information about the amount of lead stored in your various tissues. PbB measurements merely show current absorption of lead, not the effect that lead is having on your body or the effects that past lead exposure may have already caused. Past research into lead-related diseases, however, has focused heavily on associations between PbBs and various diseases. As a result, your PbB is an important indicator of the likelihood that you will gradually acquire a lead-related health impairment or disease.

Once your blood lead level climbs above 40 $\mu\text{g}/100\text{g}$, your risk of disease increases. There is a wide variability of individual response to lead, thus it is difficult to say that a particular PbB in a given person will cause a particular effect. Studies have associated fatal encephalopathy with PbBs as low as 150 $\mu\text{g}/100\text{g}$. Other studies have shown other forms of diseases in some workers

Occupational Safety and Health

with PbBs well below 80 $\mu\text{g}/100\text{g}$. Your is a crucial indicator of the risks to health, but one other factor is also extremely important. This factor is the length of time you have had elevated PbBs. The longer you have an elevated PbB, the greater the risk that large quantities of lead being gradually stored in your organs tissues (body burden). The greater overall body burden, the greater chances of substantial permanent damage.

The best way to prevent all forms of lead related impairments and diseases—short term and long term—is to maintain your PbB below 40 $\mu\text{g}/100\text{g}$. The provisions of the standard are designed with this in mind. Your employer has prime responsibility to assure that the provisions of standard are complied with both by company and by individual workers. You, as a worker, however, also have a responsibility to assist your employer in compliance with the standard. You can play a key role in protecting your own health by learning about the lead hazards and their control, understanding what the standard requires, following the standard where it governs your actions, and seeing that your employer complies with provisions governing his actions.

(4) *Reporting signs and symptoms of health problems.* You should immediately notify your employer if you develop signs or symptoms associated with lead poisoning. If you desire medical advice concerning effects of current or past exposure to lead on your ability to have a healthy child, you should also notify your employer if you have difficulty breathing during a respirator fit test or while wearing a respirator. In each of these cases your employer must make available to you appropriate medical examinations or consultations. These must be provided at no cost to you and at a reasonable time and place.

The standard contains a procedure whereby you can obtain a second opinion from a physician of your choice if the employer selected the initial physician. This procedure, however, was delayed by the Court of Appeals in March of 1979, and will not go into effect until after the Court's decision on the overall validity of the standard.

APPENDIX B TO SECTION 1910.1025— EMPLOYEE STANDARD SUMMARY

This appendix summarizes key provisions of the standard that you as a worker should become familiar with.

The appendix discusses the entire standard, but some portions of the standard were temporarily postponed (stayed) by federal court on March 1, 1979. This litigation concerns the validity of the entire lead standard, and a final decision is expected in 1980. Most of the lead standard is currently legal in effect, however. The following dis-

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sion in the Appendix notes those few provisions of the standard which have been temporarily stayed.

I. PERMISSIBLE EXPOSURE LIMIT (PEL)— PARAGRAPH (C)

The standards sets a permissible exposure limit (PEL) of fifty micrograms of lead per cubic meter of air (50 $\mu\text{g}/\text{m}^3$), averaged over an 8-hour work-day. This is the highest level of lead in air to which you may be permissibly exposed over an 8-hour workday. Since it is an 8-hour average it permits short exposures above the PEL so long as for each 8-hour work day your average exposure does not exceed the PEL.

This standard recognizes that your daily exposure to lead can extend beyond a typical 8-hour workday as the result of overtime or other alterations in your work schedule. To deal with this, the standard contains a formula which reduces your permissible exposure when you are exposed more than 8 hours. For example, if you are exposed to lead for 10 hours a day, the maximum permitted average exposure would be 40 $\mu\text{g}/\text{m}^3$.

II. EXPOSURE MONITORING—PARAGRAPH (D)

If lead is present in the workplace where you work in any quantity, your employer is required to make an initial determination of whether the action level is exceeded for any employee. This initial determination must include instrument monitoring of the air for the presence of lead and must cover the exposure of a representative number of employees who are reasonably believed to have the highest exposure levels. If your employer has conducted appropriate air sampling for lead in the past year he may use these results. If there have been any employee complaints of symptoms which may be attributable to exposure to lead or if there is any other information or observations which would indicate employee exposure to lead, this must also be considered as part of the initial determination. This initial determination must have been completed by March 31, 1979. If this initial determination shows that a reasonable possibility exists that any employee may be exposed, without regard to respirators, over the action level (30 $\mu\text{g}/\text{m}^3$) your employer must set up an air monitoring program to determine the exposure level of every employee exposed to lead at your workplace.

In carrying out this air monitoring program, your employer is not required to monitor the exposure of every employee, but he must monitor a representative number of employees and job types. Enough sampling must be done to enable each employee's exposure level to be reasonably represented by at least one full shift (at least 7 hours) air sample. In addition, these air samples must

be taken under conditions which represent each employee's *regular*, daily exposure to lead. All initial exposure monitoring must have been completed by May 30, 1979.

If you are exposed to lead and air sampling is performed, your employer is required to quickly notify you in writing of air monitoring results which represent your exposure. If the results indicate your exposure exceeds the PEL (without regard to your use of respirators), then your employer must also notify you of this in writing, and provide you with a description of the corrective action that will be taken to reduce your exposure.

Your exposure must be rechecked by monitoring every six months if your exposure is over the action level but below the PEL. Air monitoring must be repeated every 3 months if you are exposed over the PEL. Your employer may discontinue monitoring for you if 2 consecutive measurements, taken at least two weeks apart, are below the action level. However, whenever there is a production, process, control, or personnel change at your workplace which may result in new or additional exposure to lead, or whenever there is any other reason to suspect a change which may result in new or additional exposure to lead, your employer must perform additional monitoring.

III. METHODS OF COMPLIANCE—PARAGRAPH (E)

Your employer is required to assure that no employee is exposed to lead in excess of the PEL. The standard establishes a priority of methods to be used to meet the PEL. Due to the temporary ruling by the United States Circuit Court of Appeals, your employer will not be legally required to use the preferred engineering and work practice controls. Until the litigation is completed, your employer may meet the PEL by requiring you to wear respirators. Alternatively, the employer may choose to implement engineering and work practice controls even though they are not legally required. Also, OSHA's previous lead standard is still in effect. This does require your employer to use feasible engineering and administrative controls to reduce employee exposure levels, but only to a level of 200 micrograms of lead per cubic meter of air ($200 \mu\text{g}/\text{m}^3$).

IV. RESPIRATORY PROTECTION—PARAGRAPH (F)

Your employer is required to provide and assure your use of respirators when your exposure to lead is not controlled below the PEL by other means. The employer must pay the cost of the respirator. Whenever you request one, your employer is also required to provide you a respirator even if your air exposure level does not exceed the PEL. You might desire a respirator when, for example, you have received medical advice that your lead absorption should be

decreased. Or, you may intend to have children in the near future, and want to reduce the level of lead in your body to minimize adverse reproductive effects. While respirators are the least satisfactory means of controlling your exposure, they are capable of providing significant protection if properly chosen, fitted, worn, cleaned, maintained, and replaced when they stop providing adequate protection.

Your employer is required to select respirators from the seven types listed in Table II of the Respiratory Protection section of the standard. Any respirator chosen must be approved by the Mine Safety and Health Administration (MSHA) or the National Institute for Occupational Safety and Health (NIOSH). This respirator selection table will enable your employer to choose a type of respirator which will give you a proper amount of protection based on your airborne lead exposure. Your employer may select a type of respirator that provides greater protection than that required by the standard; that is, one recommended for a higher concentration of lead than is present in your workplace. For example, a powered air purifying respirator (PAPR) is much more protective than a typical negative pressure respirator, and may also be more comfortable to wear. A PAPR has a filter, cartridge or canister to clean the air, and a power source which continuously blows filtered air into your breathing zone. Your employer might make a PAPR available to you to ease the burden of having to wear a respirator for long periods of time. The standard provides that you can obtain a PAPR upon request, but this requirement has been stayed as a part of the pending litigation.

Your employer must also start a Respiratory Protection Program. This program must include written procedures for the proper selection, use, cleaning, storage, and maintenance of respirators.

Your employer must assure that your respirator facepiece fits properly. Proper fit of a respirator facepiece is critical. Obtaining a proper fit on each employee may require your employer to make available two or three different mask types. In order to assure that your respirator fits properly and that facepiece leakage is minimized, beginning on November 12, 1982, your employer must give you either a qualitative fit test in accordance with Appendix D of the standard or a quantitative fit test if you use a negative pressure respirator. Any respirator which has a filter, cartridge or canister which cleans the work room air before you breathe it and which requires the force of your inhalation to draw air thru the filtering element is a negative pressure respirator. A positive pressure respirator supplies air to you directly. A quantitative fit test uses a sophisticated machine to measure the

amount, if any, of test material that into the facepiece of your respirator.

You must also receive from your employer proper training in the use of respirators. Your employer is required to teach you to wear a respirator, to know why needed, and to understand its limitations.

Until March 1, 1980, your employer must test the effectiveness of your negative pressure respirator initially and at least six months thereafter with a "qualitative test." In this test, the fit of the facepiece is checked by seeing if you can smell a substance placed outside the respirator. If, in fact, there is appreciable leakage where the facepiece meets your face.

The standard provides that if your respirator uses filter elements, you must be given an opportunity to change the filter elements whenever an increase in breathing resistance is detected. You also must be permitted to periodically leave your work to wash your face and respirator face whenever necessary to prevent skin irritation. If you ever have difficulty in breathing during a fit test or while using a respirator, your employer must make a medical examination available to you to determine whether you can safely wear a respirator. The result of this examination may be to require you a positive pressure respirator (which reduces breathing resistance) or to provide an alternative means of protection.

V. PROTECTIVE WORK CLOTHING AND EQUIPMENT—PARAGRAPH (G)

If you are exposed to lead above the PEL or if you are exposed to lead compounds such as lead arsenate or lead azide which can cause skin and eye irritation, your employer must provide you with proper work clothing and equipment appropriate for the hazard. If work clothing is provided, it must be provided in a clean and dry condition at least weekly, and daily if your exposure to lead is greater than $100 \mu\text{g}/\text{m}^3$. Appropriate protective work clothing and equipment can include coveralls or full-body work clothing, gloves, shoes or disposable shoe coverlets, and shields or vented goggles. Your employer is required to provide all such equipment at no cost to you. He is responsible for providing repairs and replacement as necessary, and also is responsible for the cleaning, laundering or disposal of protective clothing and equipment. Contaminated work clothing and equipment must be removed in change rooms and not worn home or you extend your exposure and expose your family since lead from your clothing can accumulate in your house, car, etc. Contaminated clothing which is to be cleaned, laundered or disposed of must be placed in closed containers in the change room. A change room must be removed from protective

decreased. Or, you may intend to have children in the near future, and want to reduce the level of lead in your body to minimize adverse reproductive effects. While respirators are the least satisfactory means of controlling your exposure, they are capable of providing significant protection if properly chosen, fitted, worn, cleaned, maintained, and replaced when they stop providing adequate protection.

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V. PROTECTIVE WORK CLOTHING AND EQUIPMENT—PARAGRAPH (G)

If you are exposed to lead above the PEL, or if you are exposed to lead compounds such as lead arsenate or lead azide which can cause skin and eye irritation, your employer must provide you with protective work clothing and equipment appropriate for the hazard. If work clothing is provided, it must be provided in a clean and dry condition at least weekly, and daily if your airborne exposure to lead is greater than 200 $\mu\text{g}/\text{m}^3$. Appropriate protective work clothing and equipment can include coveralls or similar full-body work clothing, gloves, hats, shoes or disposable shoe coverlets, and face shields or vented goggles. Your employer is required to provide all such equipment at no cost to you. He is responsible for providing repairs and replacement as necessary, and also is responsible for the cleaning, laundering or disposal of protective clothing and equipment. Contaminated work clothing or equipment must be removed in change rooms and not worn home or you will extend your exposure and expose your family since lead from your clothing can accumulate in your house, car, etc. Contaminated clothing which is to be cleaned, laundered or disposed of must be placed in closed containers in the change room. At no time may lead be removed from protective

clothing or equipment by any means which disperses lead into the workroom air.

VI. HOUSEKEEPING—PARAGRAPH (H)

Your employer must establish a housekeeping program sufficient to maintain all surfaces as free as practicable of accumulations of lead dust. Vacuuming is the preferred method of meeting this requirement, and the use of compressed air to clean floors and other surfaces is absolutely prohibited. Dry or wet sweeping, shovelling, or brushing may not be used except where vacuuming or other equally effective methods have been tried and do not work. Vacuums must be used and emptied in a manner which minimizes the reentry of lead into the workplace.

VII. HYGIENE FACILITIES AND PRACTICES—PARAGRAPH (I)

The standard requires that change rooms, showers, and filtered air lunchrooms be constructed and made available to workers exposed to lead above the PEL. These requirements have temporarily been delayed by the court of appeals in situations where new facilities must be constructed, or where substantial renovations must be made to existing facilities. When the PEL is exceeded and these facilities are available, however, the employer must assure that food and beverage is not present or consumed, tobacco products are not present or used, and cosmetics are not applied, except in these facilities. Change rooms, showers, and lunchrooms, if available, must be used by workers exposed in excess of the PEL. After showering, no clothing or equipment worn during the shift may be worn home, and this includes shoes and underwear. Your own clothing worn during the shift should be carried home and cleaned carefully so that it does not contaminate your home. Lunchrooms may not be entered with protective clothing or equipment unless surface dust has been removed by vacuuming, downdraft booth, or other cleaning method. Finally, workers exposed above the PEL must wash both their hands and faces prior to eating, drinking, smoking or applying cosmetics.

All of the facilities and hygiene practices just discussed are essential to minimize additional sources of lead absorption from inhalation or ingestion of lead that may accumulate on you, your clothes, or your possessions. Strict compliance with these provisions can virtually eliminate several sources of lead exposure which significantly contribute to excessive lead absorption.

VIII. MEDICAL SURVEILLANCE—PARAGRAPH (J)

The medical surveillance program is part of the standard's comprehensive approach to the prevention of lead-related disease. Its

purpose is to supplement the main thrust of the standard which is aimed at minimizing airborne concentrations of lead and sources of ingestion. Only medical surveillance can determine if the other provisions of the standard have affectively protected you as an individual. Compliance with the standard's provision will protect most workers from the adverse effects of lead exposure, but may not be satisfactory to protect individual workers (1) who have high body burdens of lead acquired over past years, (2) who have additional uncontrolled sources of non-occupational lead exposure, (3) who exhibit unusual variations in lead absorption rates, or (4) who have specific non-work related medical conditions which could be aggravated by lead exposure (e.g., renal disease, anemia). In addition, control systems may fail, or hygiene and respirator programs may be inadequate. Periodic medical surveillance of individual workers will help detect those failures. Medical surveillance will also be important to protect your reproductive ability—regardless of whether you are a man or woman.

All medical surveillance required by the standard must be performed by or under the supervision of a licensed physician. The employer must provide required medical surveillance without cost to employees and at a reasonable time and place. The standard's medical surveillance program has two parts—periodic biological monitoring and medical examinations.

Your employer's obligation to offer you medical surveillance is triggered by the results of the air monitoring program. Medical surveillance must be made available to all employees who are exposed in excess of the action level for more than 30 days a year. The initial phase of the medical surveillance program, which includes blood lead level tests and medical examinations, must be completed for all covered employees no later than August 28, 1979. Priority within this first round of medical surveillance must be given to employees whom the employer believes to be at greatest risk from continued exposure (for example, those with the longest prior exposure to lead, or those with the highest current exposure). Thereafter, the employer must periodically make medical surveillance—both biological monitoring and medical examinations—available to all covered employees.

Biological monitoring under the standard consists of blood lead level (PbB) and zinc protoporphyrin tests at least every 6 months after the initial PbB test. A zinc protoporphyrin (ZPP) test is a very useful blood test which measures an effect of lead on your body, but this test has been temporarily stayed by the Court. Thus biological monitoring under the standard is currently limited to PbB testing. If a worker's PbB exceeds 40 $\mu\text{g}/100\text{g}$ the monitoring frequency

must be increased from every 6 months to at least every 2 months and not reduced until two consecutive PbBs indicate a blood lead level below 40 $\mu\text{g}/100\text{g}$. Each time your PbB is determined to be over 40 $\mu\text{g}/100\text{g}$, your employer must notify you of this in writing within five working days of his receipt of the test results. The employer must also inform you that the standard requires temporary medical removal with economic protection when your PbB exceeds certain criteria. (See Discussion of Medical Removal Protection—Paragraph (k).) During the first year of the standard, this removal criterion is 80 $\mu\text{g}/100\text{g}$. Anytime your PbB exceeds 80 $\mu\text{g}/100\text{g}$ your employer must make available to you a prompt follow-up PbB test to ascertain your PbB. If the two tests both exceed 80 $\mu\text{g}/100\text{g}$ and you are temporarily removed, then your employer must make successive PbB tests available to you on a monthly basis during the period of your removal.

Medical examinations beyond the initial one must be made available on an annual basis if your blood lead level exceeds 40 $\mu\text{g}/100\text{g}$ at any time during the preceding year. The initial examination will provide information to establish a baseline to which subsequent data can be compared. An initial medical examination must also be made available (prior to assignment) for each employee being assigned for the first time to an area where the airborne concentration of lead equals or exceeds the action level. In addition, a medical examination or consultation must be made available as soon as possible if you notify your employer that you are experiencing signs or symptoms commonly associated with lead poisoning or that you have difficulty breathing while wearing a respirator or during a respirator fit test. You must also be provided a medical examination or consultation if you notify your employer that you desire medical advice concerning the effects of current or past exposure to lead on your ability to procreate a healthy child.

Finally, appropriate follow-up medical examinations or consultations may also be provided for employees who have been temporarily removed from exposure under the medical removal protection provisions of the standard. (See Part IX, below.)

The standard specifies the minimum content of pre-assignment and annual medical examinations. The content of other types of medical examinations and consultations is left up to the sound discretion of the examining physician. Pre-assignment and annual medical examinations must include (1) a detailed work history and medical history, (2) a thorough physical examination, and (3) a series of laboratory tests designed to check your blood chemistry and your kidney function. In addition, at any time upon your re-

quest, a laboratory evaluation of the fertility will be made (microscopic examination of a sperm sample), or a pregnancy test be given.

The standard does not require you to participate in any of the medical procedures, tests, etc. which your employer is required to make available to you. Medical surveillance can, however, play an important role in protecting your health. You are strongly encouraged, therefore, to participate in a meaningful fashion. The standard contains a multiple physician mechanism which would give you the right to have a physician of your choice participate in the medical surveillance program. If you were dissatisfied with the physician by a physician chosen by your employer, you could select a second physician to conduct an independent analysis. If two doctors would attempt to resolve differences of opinion, and either physician to resolve any firm dispute. Multiple physician review mechanism, however, has been temporarily delayed by the Court of Appeals. As a result, generally your employer will choose the physician who conducts medical surveillance under the standard—unless you and your employer can agree on the choice of a physician. Some companies are required to have agreed in advance, for example, certain independent medical laboratories or panels of physicians. Any of these arrangements are acceptable so long as the medical surveillance is made available to workers.

The standard requires your employer to provide certain information to you to aid in his or her examination of you. This information includes (1) the standard's appendices, (2) a description of your duties as they relate to lead exposure, (3) your exposure level, (4) a description of personal protective equipment you use, (5) prior blood lead level results, and (6) written medical opinions concerning you that the employer has. After a medical examination or consultation the physician must prepare a written report which must contain (1) the physician's opinion as to whether you have any medical condition which places you at increased risk of physical impairment to health from exposure to lead, (2) any recommended special protective measures to be provided to you, (3) blood lead level determinations, and (4) recommended limitation on your use of respirators. This last element must include determination of whether you can use a powered air purifying respirator (PAPR) if you are found unable to wear a conventional pressure respirator.

The medical surveillance program under the standard may at some point require you to notify certain workers who have acquired a disease or other condition.

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... beyond the initial ... available on an annual ... level exceeds 40 µg/ ... the preceding year ... will provide infor ... a baseline to which sub ... compared. An initial ... must also be made ... (assignment) for each em ... for the first time to ... orne concentration of ... the action level. In ... examination or consulta ... available as soon as pos ... your employer that you ... or symptoms com ... with lead poisoning or ... difficulty breathing while ... or during a respirator ... can be provided a medical ... if you notify ... you desire medical ... the effects of current or ... on your ability to pro ...

... follow-up medical ex ... consultations may also be ... who have been tem ... exposure under the ... protection provisions of ... (see IX, below.)

... the minimum con ... and annual medical ... of other types of ... and consultations is ... discretion of the exam ... assignment and annual ... must include (1) a de ... and medical history, (2) ... examination, and (3) a ... tests designed to check ... and your kidney func ... at any time upon your re

... laboratory evaluation of male ferti ... be made (microscopic examination ... sample), or a pregnancy test will ...

... The standard does not require that you ... in any of the medical proce ... etc. which your employer is re ... to make available to you. Medical ... can, however, play a very im ... role in protecting your health. You ... are strongly encouraged, therefore, to par ... in a meaningful fashion. The stand ... contains a multiple physician review ... which would give you a chance ... a physician of your choice directly ... in the medical surveillance pro ... if you were dissatisfied with an exam ... by a physician chosen by your em ... you could select a second physician ... to conduct an independent analysis. The ... doctors would attempt to resolve any ... of opinion, and select a third ... to resolve any firm dispute. This ... physician review mechanism, how ... has been temporarily delayed by the ... of Appeals. As a result, generally your ... will choose the physician who con ... medical surveillance under the lead ... unless you and your employer ... agree on the choice of a physician or ... Some companies and unions ... have agreed in advance, for example, to use ... independent medical laboratories or ... of physicians. Any of these arrange ... are acceptable so long as required ... surveillance is made available to ... workers.

... The standard requires your employer to ... provide certain information to a physician ... in his or her examination of you. This ... information includes (1) the standard and ... appendices, (2) a description of your ... as they relate to lead exposure, (3) ... your exposure level, (4) a description of ... protective equipment you wear, (5) ... blood lead level results, and (6) prior ... medical opinions concerning you ... the employer has. After a medical ex ... or consultation the physician ... prepare a written report which must ... (1) the physician's opinion as to ... whether you have any medical condition ... which places you at increased risk of mater ... impairment to health from exposure to ... (2) any recommended special prote ... measures to be provided to you, (3) any ... blood lead level determinations, and (4) any ... recommended limitation on your use of ... respirators. This last element must include ... determination of whether you can wear a ... powered air purifying respirator (PAPR) if ... are found unable to wear a negative ... pressure respirator.

... The medical surveillance program of the ... standard may at some point in time ... serve to notify certain workers that they ... have acquired a disease or other adverse

... medical condition as a result of occupational ... lead exposure. If this is true, these workers ... have legal rights to compensation ... from public agencies, their employers, firms ... that supply hazardous products to their em ... ployers, or other persons. Some states have ... laws, including worker compensation laws, ... that disallow a worker who learns of a job ... related health impairment to sue, unless the ... worker sues within a short period of time ... after learning of the impairment. (This ... period of time may be a matter of months ... or years.) An attorney can be consulted ... about these possibilities. It should be ... stressed that OSHA is in no way trying to ... either encourage or discourage claims or ... lawsuits. However, since results of the ... standard's medical surveillance program can ... significantly affect the legal remedies of a ... worker who has acquired a job-related dis ... ease or impairment, it is proper for OSHA ... to make you aware of this.

... The medical surveillance section of the ... standard also contains provisions dealing ... with chelation. Chelation is the use of cer ... tain drugs (administered in pill form or in ... jected into the body) to reduce the amount ... of lead absorbed in body tissues. Experience ... accumulated by the medical and scientific ... communities has largely confirmed the ef ... fectiveness of this type of therapy for the ... treatment of very severe lead poisoning. On ... the other hand, it has also been establi ... shed that there can be a long list of ext ... remely harmful side effects associated with ... the use of chelating agents. The medical co ... mmunity has balanced the advantages and dis ... advantages resulting from the use of chelating ... agents in various circumstances and has es ... tablished when the use of these agents is ... acceptable. The standard includes these ac ... cepted limitations due to a history of abuse ... of chelation therapy by some lead compa ... nies. The most widely used chelating agents ... are calcium disodium EDTA, (Ca Na₂ ... EDTA), Calcium Disodium Versenate (Ver ... senate), and d-penicillamine (penicillamine ... or Cupramine).

... The standard prohibits "prophylactic che ... lation" of any employee by any person the ... employer retains, supervises or controls. ... "Prophylactic chelation" is the routine use ... of chelating or similarly acting drugs to ... prevent elevated blood levels in workers who ... are occupationally exposed to lead, or the ... use of these drugs to routinely lower blood ... lead levels to predesignated concentrations ... believed to be 'safe'. It should be empha ... sized that where an employer takes a ... worker who has no symptoms of lead po ... soning and has chelation carried out by a ... physician (either inside or outside of a hos ... pital) solely to reduce the worker's blood ... lead level, that will generally be consid ... ered prophylactic chelation. The use of a hos ... pital and a physician does not mean that pro

phylactic chelation is not being performed. Routine chelation to prevent increased or reduce current blood lead levels is unacceptable whatever the setting.

The standard allows the use of "therapeutic" or "diagnostic" chelation if administered under the supervision of a licensed physician in a clinical setting with thorough and appropriate medical monitoring. Therapeutic chelation responds to severe lead poisoning where there are marked symptoms. Diagnostic chelation involved giving a patient a dose of the drug then collecting all urine excreted for some period of time as an aid to the diagnosis of lead poisoning.

In cases where the examining physician determines that chelation is appropriate, you must be notified in writing of this fact before such treatment. This will inform you of a potentially harmful treatment, and allow you to obtain a second opinion.

IX. MEDICAL REMOVAL PROTECTION—PARAGRAPH (K)

Excessive lead absorption subjects you to increased risk of disease. Medical removal protection (MRP) is a means of protecting you when, for whatever reasons, other methods, such as engineering controls, work practices, and respirators, have failed to

provide the protection you need. MRP involves the temporary removal of a worker from his or her regular job to a place of significantly lower exposure without any loss of earnings, seniority, or other employment rights or benefits. The purpose of this program is to cease further lead absorption and allow your body to naturally excrete lead which has previously been absorbed. Temporary medical removal can result from an elevated blood lead level, or a medical opinion. Up to 18 months of protection is provided as a result of either form of removal. The vast majority of removed workers, however, will return to their former jobs long before this eighteen month period expires. The standard contains special provisions to deal with the extraordinary but possible case where a longterm worker's blood lead level does not adequately decline during eighteen months of removal.

During the first year of the standard, if your blood lead level is 80 µg/100g or above you must be removed from any exposure where your air lead level without a respirator would be 100 µg/m³ or above. If you are removed from your normal job you may not be returned until your blood lead level declines to at least 60 µg/100g. These criteria for removal and return will change according to the following schedule:

| | Removal blood lead (µg/100 g) | Air lead (µg/m ³) | Return blood lead (µg/100 g) |
|--------------------|--|-------------------------------|------------------------------|
| After Mar. 1, 1980 | 70 and above | 50 and above | At or below 50. |
| After Mar. 1, 1981 | 60 and above | 30 and above | At or below 40. |
| After Mar. 1, 1983 | 50 and above averaged over six months. | 30 and above | Do. |

You may also be removed from exposure even if your blood lead levels are below these criteria if a final medical determination indicates that you temporarily need reduced lead exposure for medical reasons. If the physician who is implementing your employer's medical program makes a final written opinion recommending your removal or other special protective measures, your employer must implement the physician's recommendation. If you are removed in this manner, you may only be returned when the doctor indicates that it is safe for you to do so.

The standard does not give specific instructions dealing with what an employer must do with a removed worker. Your job assignment upon removal is a matter for you, your employer and your union (if any) to work out consistent with existing procedures for job assignments. Each removal must be accomplished in a manner consistent with existing collective bargaining relationships. Your employer is given broad discretion to implement temporary removals so

long as no attempt is made to override existing agreements. Similarly, a removed worker is provided no right to veto an employer's choice which satisfies the standard.

In most cases, employers will likely transfer removed employees to other jobs with sufficiently low lead exposure. Alternatively, a worker's hours may be reduced so that the time weighted average exposure is reduced, or he or she may be temporarily laid off if no other alternative is feasible.

In all of these situations, MRP benefits must be provided during the period of removal—i.e., you continue to receive the same earnings, seniority, and other rights and benefits you would have had if you had not been removed. Earnings includes more than just your base wage; it includes overtime, shift differentials, incentives, and other compensation you would have earned if you had not been removed. During the period of removal you must also be provided with appropriate follow-up medical surveillance. If you were removed because your blood lead level was too high, you must be

provided with a monthly medical opinion caused by removal. A medical opinion must be provided medical conditions that the doctor deems appropriate. If you do not follow up medical surveillance to your eligibility for MRP.

When you are medically removed to your former job, your return to your former job means that you are entitled to wages, benefits, etc. If you had not been removed, you still be in your old job if it is determined that is where you are returned consistent with assignment discretion. You have had if no removal only seeks to maintain or expand them or diminish.

If you are removed under are also eligible for other compensation for your employer's MRP benefits by the amount that you from these other sources you obtain other employment time you are laid off with.

The standard also requires an employer voluntarily from exposure to lead on the employee's removal. In these situations, even though the standard must still be provided as and required removal. Finally, it is required, respirators substitute. Respirators removal becomes necessary alternative to a transfer job, or to a lay-off with MRP.

X. EMPLOYEE INFORMATION

Your employer is required information and training employees exposed to lead level or who may suffer from lead. This protection from lead. These employees of the associated with their work protective measures which danger of lead to their their reproductive systems under the standard. In employees, including the action level, a copy of its appendices and must players any materials provided by the Occupational Health Administration. Your employer is required this training program for August 28, 1978. After the employees must be

provide the protection you need. MRP involves the temporary removal of a worker from his or her regular job to a place of significantly lower exposure without any loss of earnings, seniority, or other employment rights or benefits. The purpose of this program is to cease further lead absorption and allow your body to naturally excrete lead which has previously been absorbed. Temporary medical removal can result from an elevated blood lead level, or a medical opinion. Up to 18 months of protection is provided as a result of either form of removal. The vast majority of removed workers, however, will return to their former jobs long before this eighteen month period expires. The standard contains special provisions to deal with the extraordinary but possible case where a longterm worker's blood lead level does not adequately decline during eighteen months of removal.

During the first year of the standard, if your blood lead level is 80 µg/100g or above you must be removed from any exposure where your air lead level without a respirator would be 100 µg/m³ or above. If you are removed from your normal job you may not be returned until your blood lead level declines to at least 60 µg/100g. These criteria for removal and return will change according to the following schedule:

| Blood lead (µg/100 g) | Air lead (µg/m ³) | Return blood lead (µg/100 g) |
|-----------------------|-------------------------------|------------------------------|
| 80 and above | 50 and above | At or below 50. |
| 70 and above | 30 and above | At or below 40. |
| 60 and above | 30 and above | Do. |

long as no attempt is made to override existing agreements. Similarly, a removed worker is provided no right to veto an employer's choice which satisfies the standard.

In most cases, employers will likely transfer removed employees to other jobs with sufficiently low lead exposure. Alternatively, a worker's hours may be reduced so that the time weighted average exposure is reduced, or he or she may be temporarily laid off if no other alternative is feasible.

In all of these situation, MRP benefits must be provided during the period of removal—i.e., you continue to receive the same earnings, seniority, and other rights and benefits you would have had if you had not been removed. Earnings includes more than just your base wage; it includes overtime, shift differentials, incentives, and other compensation you would have earned if you had not been removed. During the period of removal you must also be provided with appropriate follow-up medical surveillance. If you were removed because your blood lead level was too high, you must be

provided with a monthly blood test. If a medical opinion caused your removal, you must be provided medical tests or examinations that the doctor believes to be appropriate. If you do not participate in this follow up medical surveillance, you may lose your eligibility for MRP benefits.

When you are medically eligible to return to your former job, your employer must return you to your "former job status." This means that you are entitled to the position, wages, benefits, etc., you would have had if you had not been removed. If you would still be in your old job if no removal had occurred that is where you go back. If not, you are returned consistent with whatever job assignment discretion your employer would have had if no removal had occurred. MRP only seeks to maintain your rights, not expand them or diminish them.

If you are removed under MRP and you are also eligible for worker compensation or other compensation for lost wages, your employer's MRP benefits obligation is reduced by the amount that you actually receive from these other sources. This is also true if you obtain other employment during the time you are laid off with MRP benefits.

The standard also covers situations where an employer voluntarily removes a worker from exposure to lead due to the effects of lead on the employee's medical condition, even though the standard does not require removal. In these situations MRP benefits must still be provided as though the standard required removal. Finally, it is important to note that in all cases where removal is required, respirators cannot be used as a substitute. Respirators may be used before removal becomes necessary, but not as an alternative to a transfer to a low exposure job, or to a lay-off with MRP benefits.

X. EMPLOYEE INFORMATION AND TRAINING—
PARAGRAPH (1)

Your employer is required to provide an information and training program for all employees exposed to lead above the action level or who may suffer skin or eye irritation from lead. This program must inform these employees of the specific hazards associated with their work environment, protective measures which can be taken, the danger of lead to their bodies (including their reproductive systems), and their rights under the standard. In addition your employer must make readily available to all employees, including those exposed below the action level, a copy of the standard and its appendices and must distribute to all employees any materials provided to the employer by the Occupational Safety and Health Administration (OSHA).

Your employer is required to complete this training program for all employees by August 28, 1979. After this date, all new employees must be trained prior to initial as-

signment to areas where there is a possibility of exposure over the action level.

This training program must also be provided at least annually thereafter.

XI. SIGNS—PARAGRAPH (M)

The standard requires that the following warning sign be posted in work areas where the exposure to lead exceeds the PEL:

WARNING

LEAD WORK AREA

NO SMOKING OR EATING

This requirement, however, has been stayed by the Court of Appeals.

XII. RECORDKEEPING—PARAGRAPH (N)

Your employer is required to keep all records of exposure monitoring for airborne lead. These records must include the name and job classification of employees measured, details of the sampling and analytic techniques, the results of this sampling, and the type of respiratory protection being worn by the person sampled. Your employer is also required to keep all records of biological monitoring and medical examination results. These must include the names of the employees, the physician's written opinion, and a copy of the results of the examination. All of the above kinds of records must be kept for 40 years, or for at least 20 years after your termination of employment, whichever is longer.

Recordkeeping is also required if you are temporarily removed from your job under the medical removal protection program. This record must include your name and social security number, the date of your removal and return, how the removal was or is being accomplished, and whether or not the reason for the removal was an elevated blood lead level. Your employer is required to keep each medical removal record only for as long as the duration of an employee's employment.

The standard requires that if you request to see or copy environmental monitoring, blood lead level monitoring, or medical removal records, they must be made available to you or to a representative that you authorize. Your union also has access to these records. Medical records other than PbB's must also be provided upon request to you, to your physician or to any other person whom you may specifically designate. Your union does not have access to your personal medical records unless you authorize their access.

XIII. OBSERVATIONS OF MONITORING—
PARAGRAPH (O)

When air monitoring for lead is performed at your workplace as required by this standard, your employer must allow you or someone you designate to act as an observer of the monitoring. Observers are entitled to an explanation of the measurement procedure, and to record the results obtained. Since results will not normally be available at the time of the monitoring, observers are entitled to record or receive the results of the monitoring when returned by the laboratory. Your employer is required to provide the observer with any personal protective devices required to be worn by employees working in the area that is being monitored. The employer must require the observer to wear all such equipment and to comply with all other applicable safety and health procedures.

XIV. EFFECTIVE DATE—PARAGRAPH (P)

The standard's effective date is March 1, 1979, and employer obligations under the standard begin to come into effect as of that date.

XV. FOR ADDITIONAL INFORMATION

A. Copies of the Standard and explanatory materials can be obtained free of charge by calling or writing the OSHA Office of Publications, Room S-1212, United States Department of Labor, Washington, D.C. 20210; Telephone (202) 523-6138. The following publications are available:

1. The standard and summary of the statement of reasons (preamble), FEDERAL REGISTER, Volume 43, pp. 52952-53014, November 14, 1978.
2. The full statement of reasons (preamble) FEDERAL REGISTER, vol. 43, pp. 54354-54509, November 21, 1978.
3. Partial Administrative Stay and Corrections to the standard, (44 FR 5446-5448) January 26, 1979.
4. Notice of the Partial Judicial Stay (44 FR 14554-14555) March 13, 1979.
5. Corrections to the preamble, FEDERAL REGISTER, vol. 44, pp. 20680-20681, April 6, 1979.
6. Additional correction to the preamble concerning the construction industry, FEDERAL REGISTER, vol. 44, p. 50338, August 28, 1979.
7. Appendices to the standard (Appendices A, B, C), FEDERAL REGISTER, Vol. 44, pp. 60980-60995, October 23, 1979.
8. Corrections to appendices, FEDERAL REGISTER, Vol. 44, 68828, November 30, 1979.
9. Revision to the standard and additional appendices (Appendices D and E), FEDERAL REGISTER, Vol. 47, pp. 51117-51119, November 12, 1982.

B. Additional information about the standard, its enforcement, and your employ-

er's compliance can be obtained from the nearest OSHA Area Office listed in your telephone directory under United States Government/Department of Labor.

APPENDIX C TO SECTION 1910.1025—MEDICAL
SURVEILLANCE GUIDELINES

INTRODUCTION

The primary purpose of the Occupational Safety and Health Act of 1970 is to assure, so far as possible, safe and healthful working conditions for every working man and woman. The occupational health standard for inorganic lead¹ was promulgated to protect workers exposed to inorganic lead including metallic lead, all inorganic lead compounds and organic lead soaps.

Under this final standard in effect as of March 1, 1979, occupational exposure to inorganic lead is to be limited to 50 µg/m³ (micrograms per cubic meter) based on an 8 hour time-weighted average (TWA). This level of exposure eventually must be achieved through a combination of engineering, work practice and other administrative controls. Periods of time ranging from 1 to 10 years are provided for different industries to implement these controls. The schedule which is based on individual industry considerations is given in Table 1. Until these controls are in place, respirators must be used to meet the 50 µg/m³ exposure limit.

The standard also provides for a program of biological monitoring and medical surveillance for all employees exposed to levels of inorganic lead above the action level of 30 µg/m³ (TWA) for more than 30 days per year.

The purpose of this document is to outline the medical surveillance provisions of the standard for inorganic lead, and to provide further information to the physician regarding the examination and evaluation of workers exposed to inorganic lead.

Section 1 provides a detailed description of the monitoring procedure including the required frequency of blood testing for exposed workers, provisions for medical removal protection (MRP), the recommended right of the employee to a second medical opinion, and notification and recordkeeping requirements of the employer. A discussion of the requirements for respirator use and respirator monitoring and OSHA's position on prophylactic chelation therapy are also included in this section.

Section 2 discusses the toxic effects and clinical manifestations of lead poisoning and

¹The term inorganic lead used throughout the medical surveillance appendices is meant to be synonymous with the definition of lead set forth in the standard.

Occupational Safety and Health

effects of lead intoxication on e pathways in heme synthesis. The effects on both male and female reproductive capacity and on the fetus are discussed.

Section 3 outlines the recommended evaluation of the worker exposed to organic lead including details of the history, physical examination, and recommended laboratory tests, which are b

Permissible airborne lead levels by industry (µg)

1. Primary lead production.....
2. Secondary lead production.....
3. Lead-acid battery manufacturing.....
4. Nonferrous foundries.....
5. Lead pigment manufacturing.....
6. All other industries.....

¹ Airborne levels to be achieved without reliance on other administrative controls. While these are exposure limits.

I. MEDICAL SURVEILLANCE AND MONITORING REQUIREMENTS FOR WORKERS EXPOSED TO ORGANIC LEAD

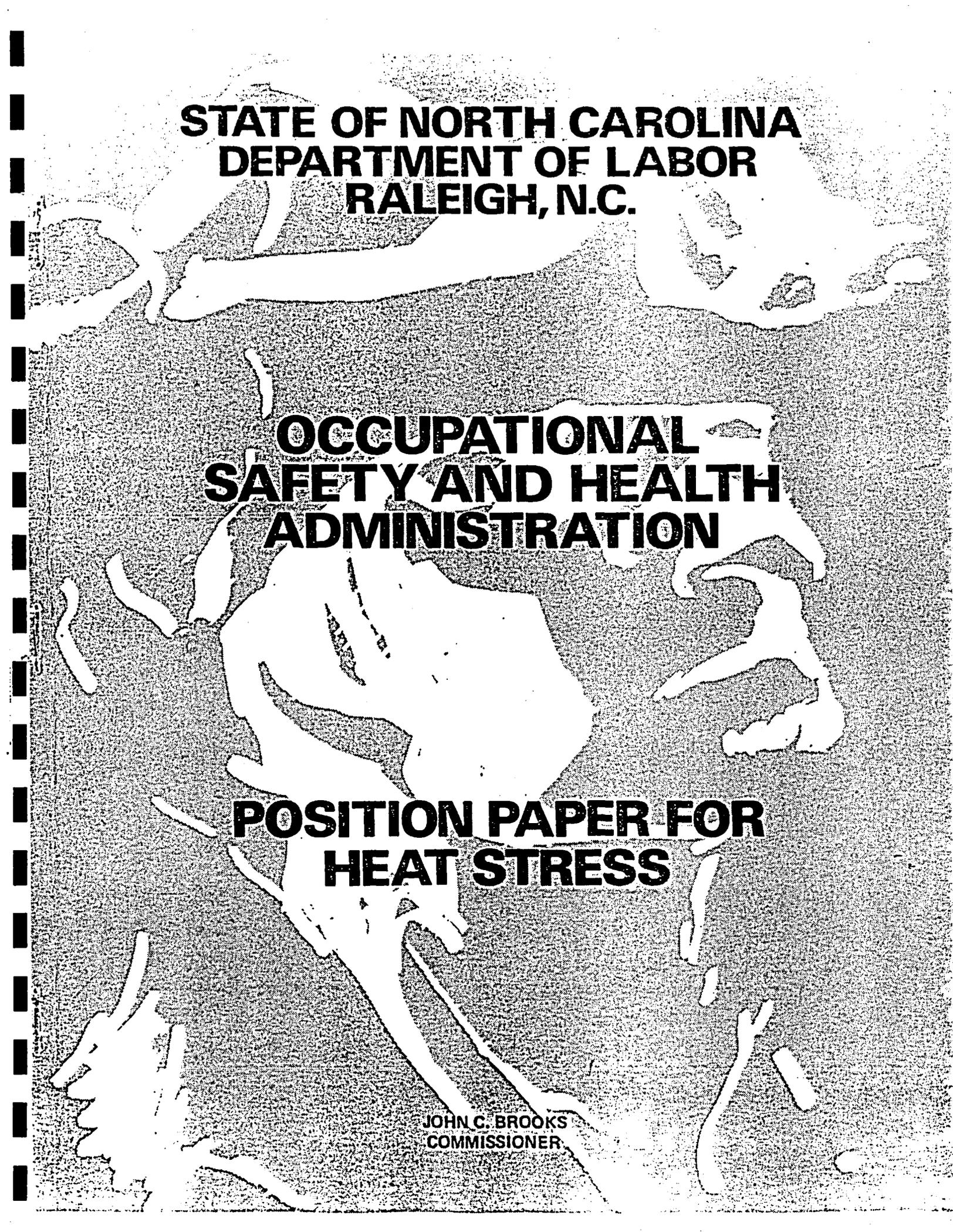
Under the occupational health standard for inorganic lead, a program of biological monitoring and medical surveillance made available to all employees exposed to lead above the action level of 30 µg/m³ for more than 30 days each year. The program consists of periodic blood sampling and medical evaluation to be performed on a schedule which is defined by preliminary laboratory results, worker complaints, and the clinical assessment of the examining physician.

Under this program, the blood lead level of all employees who are exposed to lead above the action level of 30 µg/m³ determined at least every six months. The frequency is increased to every two months for employees whose last blood lead level was between 40 µg/100 g whole blood. The level requiring employee medical attention to be discussed below. For employees removed from exposure to lead, an elevated blood lead, a new blood lead level must be measured monthly. A zinc protoporphyrin (ZPP) measurement is also recommended on each occasion that a blood lead level measurement is made. ZPP monitoring is one of several requirements of the standard that has been temporarily suspended pending litigation over the lead standard. Unless otherwise noted in this document, the provisions of the standard pertaining to medical surveillance and medical removal protection are currently in effect.

APPENDIX D

NORTH CAROLINA HEAT STRESS

POSITION PAPER



**STATE OF NORTH CAROLINA
DEPARTMENT OF LABOR
RALEIGH, N.C.**

**OCCUPATIONAL
SAFETY AND HEALTH
ADMINISTRATION**

**POSITION PAPER FOR
HEAT STRESS**

**JOHN C. BROOKS
COMMISSIONER**

NORTH CAROLINA DEPARTMENT OF LABOR
OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

ALBERT WEAVER,
ACTING DIRECTOR

HEAT STRESS

NORTH CAROLINA DEPARTMENT OF LABOR POSITION PAPER

PREPARED BY
DAVID PIERCE, PH. D.
JULY, 1977

JOHN C. BROOKS,
COMMISSIONER OF LABOR

INTRODUCTION

At the present time there is no OSHA standard for heat stress and yet the effects are sources of occupational illnesses. For this reason it was felt that a position paper was needed to clarify the documented effects and explain different methodologies that can be used for the recognition of this stressor.

It is anticipated that eventually there will be a standard for heat stress. The readers of this paper should discern, however, that the control of heat stress can be achieved in several ways and quite often with minimal financial expenditures.

Specifically, this paper was prepared to outline the major effects of heat stress and to delineate the methodology chosen by the North Carolina Department of Labor for measurement of heat stress. Further assistance in assessing stress from hot environments can be obtained through the OSHA Division of the Department of Labor.

Albert Weaver
July, 1977

TABLE OF CONTENTS

| | Page |
|--|------|
| The Problem | 1 |
| Thermoregulation | 1 |
| The Principal Factor | 2 |
| Heat Balance | 2 |
| Heat Illnesses and Prevention | 4 |
| Climatic Factors | 6 |
| Thermal Indices | 7 |
| North Carolina Adopted Methodology | 10 |
| Charts and Tables | 12 |
| Heat Stress | 15 |
| Allowable Exposure Time | 17 |
| Heat Stress Controls | 21 |
| Bibliography | 22 |

THE PROBLEM -- AN HISTORIC EXAMPLE AND CURRENT CONTROL EFFORTS

The classic Black Hole of Calcutta is more than a figure of speech. History buffs will recall that in 1773, 146 British prisoners were crammed into a room 23 meters square (about 16 feet by 15 feet). After one night only 23 remained alive. Contrary to popular belief, death likely resulted from heat stress and not from suffocation. (4)

Although there are no Black Holes in North Carolina, there are, in all likelihood, industrial sites in the state where heat stress may prove to be excessive. NIOSH has recommended a set of standards (13) to the United States Department of Labor in the first formal step toward coping with the problem on a national scale.

The key to successful monitoring is the selection and application of the best possible techniques of measurement. This publication is the North Carolina Department of Labor's first step in preparing to propose its own standard.

THERMOREGULATION

To achieve a condition of near total comfort, the thermal load on body mechanisms must be zero or at least tolerable. In conditions which any individual would consider uncomfortable, the body's effector mechanisms will cause changes in the mean skin temperature and the sweat secretion in order to maintain the body's heat balance. Physiological strain (upon body mechanisms) can thus be expressed by thermal load for a given activity level. In mathematical terms, Fanger (4) indicates this expression is

$$Y = f \left(L, \frac{H}{A_{DU}} \right) \quad \text{where}$$

Y is mean thermal rate

L is thermal load

H is internal heat production

A_{DU} is body surface area

Modifications in behavior (where and when possible) serve to thermoregulate body mechanisms, the failure or curtailment of which might otherwise cause heat stress. These include proper preparation for a given task (selection process and acclimatization), administrative controls (rest and/or avoidance of hazard), judicious replacement of lost vital chemicals (water and salt), engineering controls, and proper protection (clothing and other shielding).

Thermoregulation breaks down when environmental conditions are severe. Thus, a prescriptive zone (cooler than "excessive" or severe level) is defined and used as the criterion for setting limits in industrial work.

THE PRINCIPAL FACTOR

Heat stress and ensuing illnesses normally occur when the temperature of the air around the body equals or exceeds that of the body itself and the body's built-in cooling systems (circulatory and perspiratory) are unable to compensate adequately or dissipate the excessive heat. Although numerous variables contribute to the problem, body temperature variation and its control (or lack of) is the key element.

For purposes of delineating contributors to body temperature the core and the shell or periphery are defined. In anatomical terms, the core has no particular location but rather is a concept with temperature measured at various internal but accessible sites [oral, rectal or by an ingested transmitter (7)]. Core temperatures determined by whatever method (direct reading or telemetry) are relatively independent of external factors over a broad range of environments but are related to rate of working or activity. In his classic work of 1938, Nielsen suggested that "a very efficient and sensitive mechanism controls the core temperature and that the setting of this thermostat depends on the rate of working". (7)

The shell (limbs and periphery) is composed of superficial tissues and its temperature has much wider variation than the core. The two are inherently inseparable and mutually dependent since changes in blood flow alters the conductance between the core and the shell and heat is lost from the skin surface through sweating. (7)

A practical upper limit for core temperature has been proposed by NIOSH in its recommendations for a heat stress standard. "The worker's deep body temperature should not be permitted to exceed 39 degrees C (100.4 degrees F)." (13) This level is coincident with a World Health Organization recommendation in 1967 and the basic precept of the Belding and Hatch Heat Stress Index that deep body temperature not increase by more than one degree C. (1) The significance of the 39 degrees C cutoff point is that the prescriptive zone is exceeded and the subject is in a zone where a relatively small increase of environmental heat will substantially increase deep body temperature. Fortunately, a knowledge of the core temperature for any given subject is neither necessary (required by any proposed standard) nor feasible (no socially acceptable method of field measurement).

HEAT BALANCE

The various heat regulatory mechanisms of the body work to maintain a uniform core temperature and do so by assuring a loss-gain balance between the key factors. Generally, this relationship includes all or most of the following items. (7)

(1) $M - W = E + C + K + R + S$ where

M - W is rate of productivity of body heat
M is rate of metabolic energy production
W is rate of external working
E is rate of heat loss through moisture evaporation on the skin
C is rate of gain or loss through convection
K is rate of gain or loss through conduction
R is rate of gain or loss through radiation
S is rate of heat storage in tissues

Units for the above quantities are normally Kilo calories or BTU's per hour. In some balance analyses, surface areas (dependent on body weight and height) are included. Metabolic energy production (M) is the result of action of all processes active in the creation or destruction of protoplasm. It is a chemical change in all living cells which provides the energy for vital processes. Typical work values may vary from 360 BTU/hour (sitting at ease) to 2600 BTU/hour (heavy, rapid lifting).

The factors on the right side of the equation (1) are the basic physical processes which contribute to heat passage (from places of higher to places of lower temperature). Conduction occurs when heat passes through solids or fluids not in motion; convection occurs when heat passes via a moving fluid (gas or liquid); radiation occurs as heat crosses a gap between surfaces (no medium necessary). Heat is lost by evaporation as a change of state (water to vapor) occurring without a direct temperature change. Some heat is stored in tissues during metabolic energy production.

In stating the balance of heat in a simplified form

$$(2) M = E + C + R$$

it is conceded that heat generated within the body (by external activity or to overcome an absence of heat, i.e. "cold") must equate to the sum of losses due only to evaporation, convection and radiation with the all other factors being relatively insignificant. The physical and measurable quantities necessary to determine the amount of heat exchanged by a human body with its environment are air temperature, velocity, moisture content, and radiant temperature.

When core temperatures remain within the range of 99.4 degrees F to 100.4 degrees F (limits necessary to avoid heat disorders), a balance is

achieved and all regulatory systems are functioning adequately. An increase in M causes core temperatures to rise and the body mechanisms bring about subsequent increases in heat loss.

The actual mechanics of the body's efforts to maintain a heat balance are twofold: (1) core heat is carried to the surface (skin) and beyond by additional flow of blood through dilated vessels and (2) increased activity of sweat glands helps cool skin as sweat evaporates to a limiting rate of 2400 BTU/hour which represents a loss of one liter of perspiration per hour (capacity for an average acclimatized male to sweat for eight hours). (6)

HEAT ILLNESSES AND PREVENTION

Physical disorders attributable to excessive exposure to heat are numerous but can be placed in five etiologic categories:

1. Thermoregulatory failure
Heat stroke and heat hyperpyrexia
2. Orthostatic hypotension
Heat syncope
3. Salt and water imbalance
Heat exhaustion and heat cramps
4. Behavioral disorder
Heat fatigue
5. Skin disorders and sweat gland injury
Heat rash and anhidrate heat exhaustion

Of the above afflictions, the most common appear to be heat stroke, heat exhaustion and heat cramps. (12)

Heat Stroke is a response to heat characterized by extremely high body temperatures and upsetting or failure of the sweating mechanism. It is an immediate, life-threatening emergency for which medical care is urgently needed. Specific indicators are extremely high body temperature (106 degrees F or above); hot, red, dry skin; rapid and strong pulse; and possible loss of consciousness by victim. Steps should be taken to immediately cool the victim by any or all of several means -- removal of clothing, sponging with water or alcohol, cold packs, submersion in tub of cold water. Stimulants are withheld.

Heat Exhaustion is a response characterized by fatigue, weakness, and collapse due to intake of water inadequate to compensate for fluids lost through sweating. Specific indicators are nearly normal body temperature; pale, clammy skin; profuse perspiration; weakness, headaches, nausea (possible vomiting); and dizziness and possible fainting. The victim should be made to lie down with feet elevated, given salt water and cooled.

Heat Cramps involve muscular pains and spasms due largely to loss of salt from the body in sweating or to inadequate intake of salt. Leg and abdominal muscles are likely affected first. Pressure or massage will relieve spasm. Salt water should be given for an hour.

Observable environmental and biological factors of significance to the safety and health officers or industrial managers include the following: (13)

Heat Stroke

Lack of acclimatization and lack of physical fitness
Sustained exertion under environmental heat
Individual susceptibility, pre-existing and chronic ailments
Drug use and abuse

Heat Exhaustion

Lack of acclimatization and physical fitness
Lack of indoctrination in hot weather hygiene
Failure to replace salt and/or water lost in sweat
Work pauses insufficient in frequency and duration
Improper clothing (excessive or inadequate)
Pre-existing physical conditions

Heat Cramps

Heavy sweating and ingestion of water without replacing lost salt

The above disorders can be prevented through an understanding of the bio-mechanics involved and proper attention to environmental measures. (13) These include:

1. Initial personnel screening and periodic health evaluation.
2. Acclimatization; that is, a gradual increase in physical activity-in the heat during the first four to ten days on the job.
3. Properly spaced intervals for rest in cooler recovery areas. (Add additional workers if pace is set by job.) Encourage workers to self-limit exposure.
4. Ensuring an ample and easily available (within 200 feet) supply of drinking water -- up to two gallons per person per eight hour shift.
5. Judicious use of supplemental salt during acclimatization and adequate salt and potassium intake at meal time.
6. Avoidance of indiscriminate intake of salt and resulting potassium depletion. Recommendations vary from 1 teaspoon per 1 quart (AMA) to 1 teaspoon per 10 quarts (Industrial Hygiene Foundation) in drinking water. (5)

7. Restful sleep in quarters cooled mechanically or by natural ventilation.
8. Proper clothing, including protective equipment if needed.
9. Engineering control of heat stress at hot work locations. See Table 5. (13)
10. Indoctrination of supervisors and workers in hot weather hygiene.
11. Distribution of work load over entire work day and scheduling of hottest jobs in coolest part of work shift when possible.

CLIMATIC FACTORS

If the thermal environment occupied by a given individual is to be controlled or modified, the key factors mentioned earlier (air temperature, velocity, moisture content, and radiant temperature) must be maintained or altered accordingly.

The free air or dry bulb temperature away from the body will differ from that on or of the body. Heat exchange by convection and radiation is directly dependent on this difference. If air temperature exceeds body temperature, the body will tend to gain heat.

Radiant temperature differences cause heat to be transmitted across a gap or space (by electromagnetic waves) and are determined from measurements of air temperature, velocity and globe temperature. The globe is normally a hollow six inch sphere with a blackened outside surface and a thermometer inserted to its center. (The copper floats used in water system shut-off valves are satisfactory and practical.) The recorded temperature results from radiant heat absorbed by the globe and the convective heat.

Humidity is a measure of the air's moisture content. The more commonly used "relatively humidity" is a ratio of the actual moisture content of the air (prevailing partial vapor pressure) and the total moisture that the air could hold (saturated water vapor pressure). A psychrometric chart yields humidity when free air temperature (dry bulb) and wet bulb temperature are known. The latter is determined by placing a fabric sleeve over the bulb of the thermometer which is then soaked in water. When humidity is high, evaporation cannot occur as efficiently (heat loss is curtailed) and in the limiting case of wet skin (100 percent humidity) evaporation ceases or is annulled by an equal amount of condensation.

The movement of air, whether natural or forced, in an environment and over and around the subject contributes to heat control by dissipating convective heat from the body and improving evaporation rates. Air velocity is determined by a thermoanemometer (e.g. Anor or Willson) which measures air motion by the rate of cooling of a hot wire (heated thermocouple) at the tip of a probe. (14) These instruments have the advantages of a relatively high

sensitivity and are non-directional. Velometer measurements (uni-directional) are normally not satisfactory except to determine air supplied to the worker by fans or ducts. Recordable air velocities range from 20 to 1,000 feet per minute.

In addition to the typical test set-up shown in Figure 1, NIOSH has examined various portable heat stress monitors (11) including the packaging of most of the necessary instrumentation into a hard hat. The remaining sensors and auxiliary equipment (batteries, telemetry units, etc.) would then have to be included on the subject's belt.

THERMAL INDICES

Of the myriad factors contributing to heat exchange between the human skin and environment, it would be both convenient and expedient if those of any real significance could be conclusively identified and integrated into a single quantity. The prime advantage would be that of allowing a meaningful comparison of the effects of different environments, work rates, and clothing.

The basic problem of heat identification and control is a relatively simple one -- of stress and strain. It is unlike the classic verification of Hooke's Law in which one applies a stress to a spring which induces a strain. The elasticity properties of the material in question are then used to compare the theoretical change in spring length with that measured. The matter of applying stress (in this case, heat) to a human subject and measuring the physical (and emotional) strain is far more complex since the stress cannot be confined to environmental terms and the resulting induced strain is not a pure consequence of the stress and personal physiology.

If the various components in a thermal stress-strain relationship could be reduced to a simple quantity, it is doubtful that such an integration of factors would apply to various subjects and varying work rates. Although Kerlake (7) concludes that in principle such a solution is possible, it is impractical to expect to find a simple means of combining the subject's physiological characteristics with the environment's physical factors. When any or all of these factors vary extensively, it would be expected that a trade-off of accuracy and reliability against restricting application of a given index to a relatively narrow group of subjects would be necessary.

The following is a brief review (5), (7) of the more important heat stress indices in current use, including a cursory evaluation of each based on known strengths and limitations.

BIO-PHYSICAL INDICES (based on heat exchange analysis)

1. Belding and Hatch Heat Stress Index (HSI)

Since this method will likely become the basis, with some modifications, for North Carolina's proposed heat stress standard, it will be discussed more fully in a subsequent section. The basic quantities, rate of evaporative heat loss needed to maintain heat balance and maximum evaporative capacity, are estimated. Their ratio is the heat stress

index. Calculations are independent of subject responses and are based on constant skin temperature (35 degrees C) and body surface area (1.86 m²). With these restrictions and exclusion of respiratory heat exchange, the HSI can be found from five nomographs (Table 3).

Although intended for industrial application, original measurements were made on nude subjects. Originally Belding and Hatch did not consider the introduction of a layer of clothing to be a serious deviation. Later Belding et al. concurred with McKarns and Brief (8) that values for the contributions of radiation and convection would "probably be 30 to 40 percent greater if the men were nude." Modified nomographs (see Figure 3) account for clothing.

2. Givone's Index of Thermal Stress (ITS)

This method first predicted the sweat rate required for thermal equilibrium in subjects wearing summer clothing but later included subjects with other coverings and allowed for solar radiation. The same basic quantities used in HSI are estimated and from the ratio of required to maximum energies, a sweating efficiency is found. The ITS is the sweat rate required for thermal equilibrium. Again, skin temperature is assumed constant and the author provides a method that is "simple and workable by an astute blending of theory and empiricism". Kerslake considers the ITS to be "better" than the other rationally-based methods (HSI) in that although it is more complicated, this disadvantage is offset by its more logical statement of heat stress.

Its equivalence predictions check better (than HSI) with both theoretical expectation and practical experience. The ITS can be modified to accommodate various amounts and types of clothing and to allow for variations in subject shape and size.

PHYSIOLOGICAL INDICES (based on responses to known thermal stresses)

1. McArdle's Predicted Four-Hour Sweat Rate (P4SR)

This method is based on World War II studies of Navy men on four-hour watches in hot climates for which the subjects were acclimatized to moderate work. The actual stress index is the total sweat lost during the four-hour exposure by persons wearing either shorts or overalls. A nomogram devised by trial and error yields a basic sweat rate which can then be modified according to limited categories of work activity (7) and clothing configurations. It is necessary to measure the basic quantities of globe temperature, wet and dry bulb temperatures, air velocity and estimate a metabolic rate.

2. Wet Bulb Globe Temperature Index (WBGT)

Using a simple weighing of only wet bulb and globe temperature readings

$$(1) \text{ WBGT} = 0.7T_{wb} + 0.3T_g \quad (\text{indoors})$$

Yaglou and Minard devised perhaps the most readily obtainable index. The method was intended originally for use in open desert conditions and has, in fact, contributed to a significant decrease in heat disorders at military training bases such as the Marine Corps Recruit Depot at Parris Island, South Carolina. Its use is generally restricted and appropriate to those conditions for which heat stress reaches a critical level. Its virtues include simplicity and the option of direct readings through rugged, portable, electronic equipment.

When the WBGT is applied in the outdoors, equation (1) is altered to include an air (dry bulb) temperature component

$$(2) \text{ WBGT} = 0.7T_{wb} + 0.2T_g + 0.1T_a$$

with the latter factor accounting for solar radiation. An overall value is calculated on a time-weighted average basis for relatively continuous exposure. If exposure is not continuous (less than 15 minutes duration at a time) then a two-hour time-weighted average would be used.

The recommendations forwarded to the United States Department of Labor by NIOSH used the WBGT as the basis for determining heat stress with additional restrictions on core temperatures, work practices (acclimatization, rest, etc.) and monitoring-record-keeping. Kerslake concludes that "something very like the WBGT might well be the ideal" (heat stress index). More recently, Brown and Dunn have suggested that the WBGT become the basis for an international standard on thermal stress. (3)

SUBJECTIVE INDICES (based on quantitative grading of comfort)

1. Effective Temperature of Yaglou (ET)

The method is based on instantaneous impressions of subjects moving back and forth from one conditioned room to another. The ET is that of still, saturated air which would correspond to an equivalent sensation. Only wet and dry bulb temperatures are needed to use a nomogram. Numerous modifications have been proposed since the original scale. The ET would coincide with the WBGT only in still air. It has received widespread use in steady state applications since the 1920's and may not readily lose favor among those who understand it but are not physiologically oriented. Although based on initial impressions which do not hold after prolonged exposure, it is the basis for the WBGT and thus aids in identifying those most seriously affected by heat stress.

2. Equivalences En Séjour (ES) of Missenard

To circumvent the shortcomings of immediate personal perceptions of the differences between environments (ET), the ES was devised to

yield impressions shortly after transfer or after at least half an hour (en séjour). Nomograms for either clothed or nude subjects are entered at a given air velocity to yield an ES directly which is that for an environment of still, saturated air producing an equivalent sensation. The ES appears to be superior to the more time-honored ET for steady state sensation.

NORTH CAROLINA ADOPTED METHODOLOGY

After evaluating the various means of realistically determining heat stress, the North Carolina Department of Labor has elected to employ, at least in the initial data-gathering phase, the method devised by Belding and Hatch (1) as modified by McKarns and Brief. (8) This technique for relating a worker's physiological stress to his immediate working environment was first proposed in 1955 as a revision of the effective temperature index while Belding and Hatch were members of the faculty at the University of Pittsburgh.

Basically, the index is a ratio (α/β) (multiplied by 100) where (α) is the evaporation of that amount of sweat required (evaporation required) for a man to maintain body temperature within the normal range and (β) is that amount of sweat that can be evaporated into, or accepted by, the particular climate (maximum evaporative capacity) in which he is working or living. (6) The "man" in question is a "standard man" defined in Fundamentals of Industrial Hygiene as "a theoretical physically fit man of standard (average) height, weight, dimensions, and other parameters (9) Normal sweating capacity is implicit since thermal equilibrium can be maintained only through the cooling effect of sweating.

As many as 15 variables contribute to heat stress, but fortunately for the evaluator, these can be reduced to five quantities. Four are determined by direct readings (wet bulb, dry bulb, globe temperature and air velocity). The fifth quantitative is a somewhat subjective estimate of expended energy (metabolism) for a variety of activities (Table 1) from Brief and NIOSH (13), that of ACGIH (15), or of Passmore and Durnin (10) in Table 2. The latter quantity could be determined by direct measurements of pulse rate, sweat loss, or oxygen consumption. Such measurements would be impractical in a field situation.

Of the four necessary measurements, three can be taken with a minimal set-up time (see Figure F for apparatus set-up). Globe temperature, however, requires an equilibrium period of 20 minutes. Additional requirements for gathering reliable data include (1) shielding the dry bulb thermometer from the sun or other radiant surfaces (while permitting free air movement around the bulb), (2) placing the thermometers at approximately chest level of the workers, (3) assuring that the wet bulb wick will be totally absorbent (capillarity effectiveness) by soaking it overnight prior to use (wash new wicks), and (4) wetting the wick with distilled water. (15)

The Belding and Hatch method (modified) is relatively easy to use, rationally-based, and successfully field-tested. Its limitations are admitted but considered to be fewer in number and less severe than those placed on any of the other techniques for arriving at a heat stress index.

The nomograms in Figure 2 are used in the following steps:

1. In Chart A find the intersection of the globe temperature with the air speed and drop a vertical line to the lower horizontal axis.
2. Extend this vertical line to the metabolism value in Chart B. From this point extend a horizontal line to the right vertical axis.
3. Go now to Chart X and find the intersection of the wet bulb and dry bulb temperatures and extend a horizontal line to the right vertical axis.
4. Continue this line to the appropriate air speed on Chart Y. Raise a vertical line from this point to the top horizontal axis.
5. Finally, continue the two lines terminated on Charts B and Y until they intersect on Chart Z. Read this value as the Heat Stress Index.
6. Evaluate this number using Table 3 to determine the extent of strain (6) in subjective terms.

Deficiencies in the final evaluation may result from the actual subject (1) differing from the "standard man" and (2) being clothed (index developed on nude or semi-nude subjects). The latter potential error can be reduced and the heat stress index made more realistic for clothed subjects by reducing values in Chart A of Figure 2 by 40 percent or by using the revisions of McKarns and Brief (see Figure 3). (6) A more objective assessment of the actual problem results from a calculation of the allowable exposure time (see page 17).

The ease and convenience of use of the Belding and Hatch method should not be allowed to obscure the fact that neither this method nor any of the others will predict stress accurately under all conditions and circumstances (consensus of all index authors). (9) Qualitative observations, personal interviews, and the evaluator's intuition should not be discounted.

Without minimizing the potential hazards involved in excessive exposure to hot environments, it appears that the natural selection process protects the majority of workers subject to heat stress. Those who "cannot stand the heat" seem to quickly learn to "stay away from the fire" or "out of the kitchen" (or out of the foundries, steam tunnels, brick factories, or boiler rooms) and thus, avoid the "Black Holes" of industry.

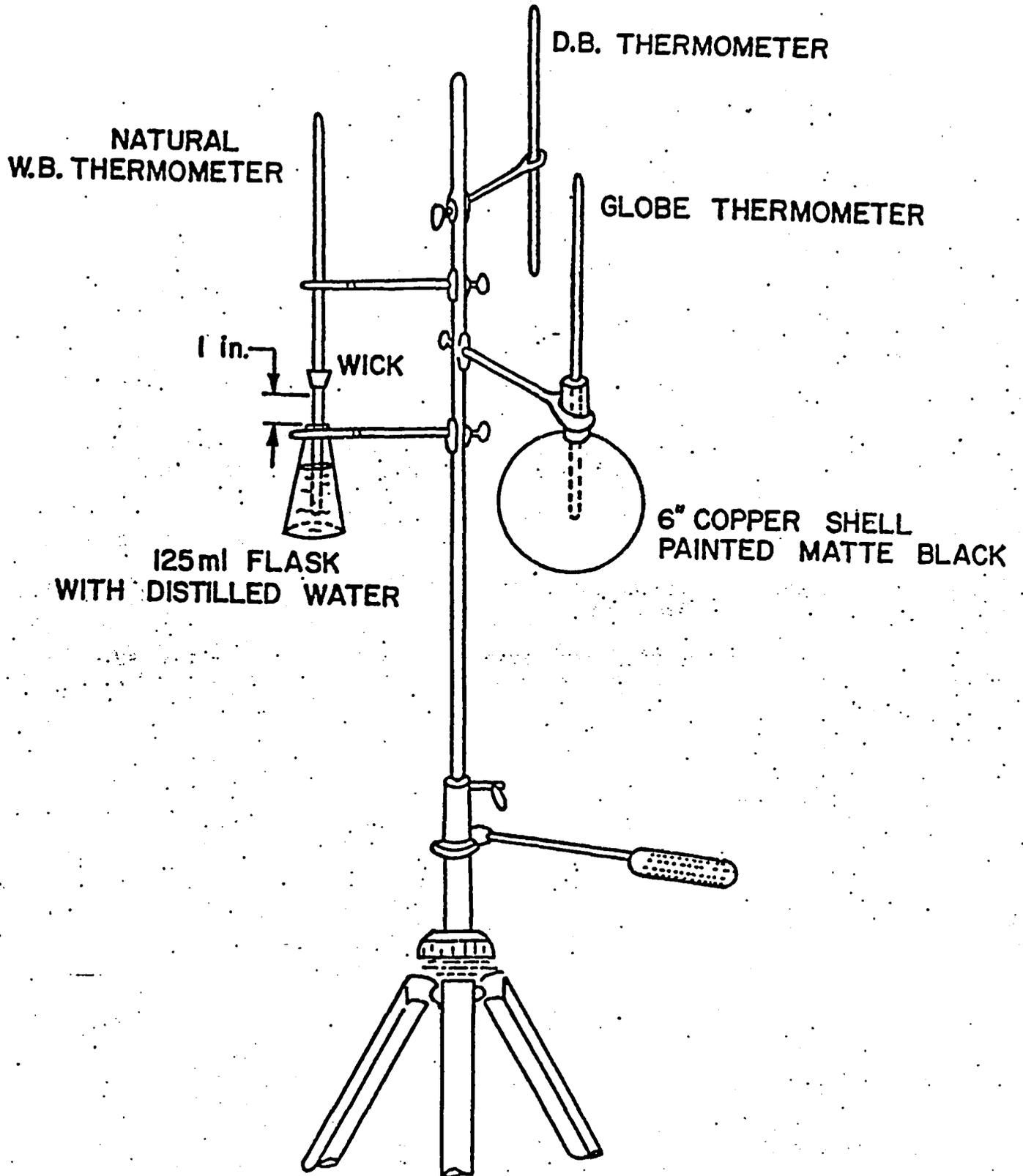


Figure 1

SUGGESTED INSTRUMENT ARRANGEMENT FOR ENVIRONMENTAL MEASUREMENTS

TABLE 1
AVERAGE ENERGY EXPENDITURE, M,
WHILE PERFORMING SELECTED ACTIVITIES

Values supplied for 70 kg (154 lb.) man, for most activities,
adjustment for energy cost is proportional to body weight.

| Body Position and Activity | M, BTU/hour | |
|---|-------------|-----------|
| | Typical | Range |
| SITTING, at ease | 360 | |
| light hand work(writing, typing) | 410 | 380-430 |
| moderate hand and arm work (drafting, light drill press, light assembly, tailoring) | 500 | 450-550 |
| heavy hand and arm work (nailing, shaping stones, filing) | 840 | 720-960 |
| light arm and leg work (driving car on open road, machine sewing) | 670 | 600-770 |
| moderate arm and leg work (local driving of truck or bus) | 860 | 720-960 |
| STANDING, at ease | 460 | |
| moderate arm and trunk work (nailing, filing, ironing) | 890 | 720-960 |
| heavy arm and trunk work (hand sewing, chiseling) | 1440 | 960-1920 |
| WALKING, casual (foreman, lecturing) | 720 | 600-840 |
| moderate arm work (sweeping, stockroom work) | 1080 | 960-1200 |
| carrying heavy loads or with heavy arm movements (carrying suitcases, scything, hand-mowing lawn) | 1680 | 1440-1920 |
| transferring 35 lb. sheet materials 2 yds. at trunk level, 3 times per minute | 890 | |
| pushing wheelbarrow on level at | | 700-1440 |
| 2 mph | 770 | |
| 3 mph | 960 | |
| 4 mph | 1420 | |
| up, 5 degree grade at 3 mph | 2040 | |
| mailman climbing stairs | 2880 | |
| down, 5 degree grade at 3 mph | 820 | |
| JOGGING, level, 4.5 mph | 1800 | |
| RUNNING, level, 7.5 | 3050 | |
| LIFTING, 44 lbs., 10 cycles per min., floor to waist | 1970 | |
| floor to shoulder | 2590 | |
| SHOVELING, 18 lb. load 1 yd. with 1 yd. lift, 10 times per min. | 1920 | |
| HEAVY ACTIVITY AT FAST TO MAXIMUM PACE | | 2400-4800 |

TABLE 2
ENERGY EXPENDITURES, M, FOR VARIOUS ACTIVITIES^a

| ACTIVITY | M (BTU/HR) | ACTIVITY | M (BTU/HR) |
|---------------------------------|------------|----------------------------|------------|
| Typing, electrical ^b | 270-330 | Machine fitting | 1000 |
| Typing, mechanical ^b | 300-375 | Tractor plowing | 1000 |
| Lying at ease | 334-360 | Grass cutting | 1020 |
| Sitting at ease | 380-395 | Hoeing | 1045 |
| Standing at ease | 405-450 | Mixing cement | 1115 |
| Draftsman | 430 | Walking on job | 1165-1610 |
| Drilling, machine | 430 | Pushing wheelbarrow | 1190-1660 |
| Light assembly work | 430 | Chiseling wood | 1355 |
| Armature winding | 525 | Shoveling | 1285-2495 |
| Printer | 525 | Loading mixer | 1425 |
| Light machine work | 570 | Digging trenches | 1425-2090 |
| Machine wood sawing | 570 | Gardening, digging | 1445 |
| Measuring wood | 570 | Brush clearing | 1450 |
| Medium assembly work | 640 | Sawing wood | 1500-1790 |
| Radio mechanics | 640 | Forging | 1520-1595 |
| Driving a car | 670 | Tending heating furnaces | 1595-3850 |
| Sheet metal worker | 715 | Working with axe | 1640-5730 |
| Shoe manufacturing | 715 | Drilling wood, hand | 1665 |
| Walking, casual | 715-925 | Scrubbing | 1665 |
| Machinist | 740 | Cross cutting with bucksaw | 1780-2500 |
| Drilling rock | 880-2255 | Climbing stairs or ladder | 1830-3140 |
| Drilling coal | 900-2255 | Planing wood | 1925-2160 |
| Weeding | 905-1855 | Tree felling | 1950-3020 |
| Bricklaying | 950 | Trimming felled trees | 2070-2760 |
| Timbering | 975-2140 | Slag removal | 2500-3000 |
| Plastering walls | 975 | | |

^aFrom reference 10. Used with permission.

^bWomen

ENTER A. Drop vertical line from intercept of globe temperature with air speed; thus get combined radiation and convection heat load. Extend vertical line to

ENTER B. At intercept with metabolism, draw horizontal line: obtain total heat load in terms of evaporation required for heat balance (e_{req}). Extend horizontal line to ENTER C.

ENTER X. Draw horizontal line from intercept of db and wb temperature: obtain vapor pressure gradient between saturated skin at 95 F and ambient air. Extend line to

ENTER Y. At intercept with air speed draw vertical line: obtain maximum evaporation from wet skin at 95 F (E_{max}). Extend line to

ENTER Z. Move to intercept with horizontal line from C. (If E_{max} exceeds 2400, enter Z at 2400). READ HEAT STRESS INDEX VALUE.

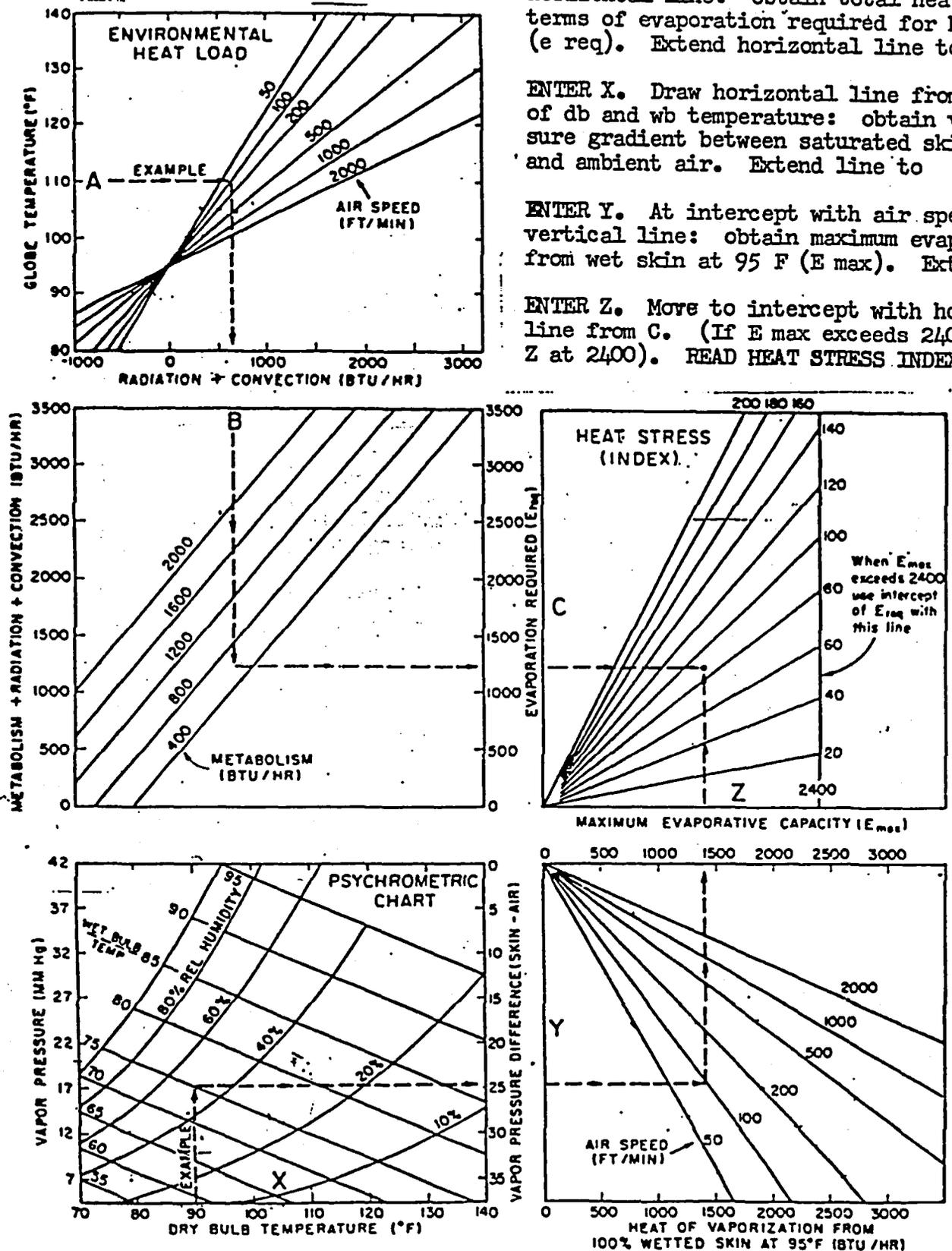


Figure 2 - Flow Charts for Determining Heat Stress Index.

TABLE 3

Evaluation of Values in Belding and Hatch H.S.I.

| Index of Heat Stress | Physiological and Hygienic Implications of 8-hr. Exposures to Various Heat Stresses |
|----------------------|--|
| -20 -10 | Mild cold strain. This condition frequently exists in areas where men recover from exposure to heat. |
| 0 | No thermal strain. |
| +10 | Mild to moderate heat strain. Where job involves higher intellectual functions, dexterity, or alertness, subtle to substantial decrements in performance may be expected. In performance of heavy physical work, little decrement expected unless ability of individuals to perform such work under no thermal stress is marginal. |
| 40 50 60 | Severe heat strain, involving a threat to health unless men are physically fit. Break-in period required for men not previously acclimatized. Some decrement in performance of physical work is to be expected. Medical selection of personnel desirable because these conditions are unsuitable for those with cardiovascular or respiratory impairment or with chronic dermatitis. These working conditions are also unsuitable for activities requiring sustained mental effort. |
| 70 80 90 | Very severe heat strain. Only a small percentage of the population may be expected to qualify for this work. Personnel should be selected (a) by medical examination, and (b) by trial on the job (after acclimatization.) Special measures are needed to assure adequate water and salt intake. Amelioration of working conditions by any feasible means is highly desirable, and may be expected to decrease the health hazard while increasing efficiency on the job. Slight "indisposition" which in most jobs would be insufficient to affect performance may render workers unfit for this exposure. |
| 100 | The maximum strain tolerated daily by fit, acclimatized young men. |

ALLOWABLE EXPOSURE TIME* - MCKARNS AND BRIEF

Activity (Use of Figure 3)

Step

- 1 Find V on line 1 and connect to t_a on line 2. Read C on line 3.
If $t_a > 95^\circ$ F use + side.

Obtain dewpoint from standard psychrometric chart (Tables 4a and 4b) using t_a and t_{wb} .
- 2 Connect V on line 1 to dewpoint on line 4. Read E_{max} on line 5.
- 3 Connect V on line 1 to temperature difference ($t_g - t_a$) on line 6. Read K on line 7. Go to bottom chart.
- 4 Connect K on line 7 (bottom chart) to t_g on line 8. Read radiant wall temperature (t_w) on line 9.
- 5 Project value on line 9 to line 10 and read radiation.
- 6 Connect radiation on line 10 to metabolism on line 11. Read sum of R & M on line 12.
- 7 Transfer C from step #1 (upper chart) to line 3 in bottom chart (note if + or -) and connect to R & M on line 12. Read E_{req} on line 13.**
- 8 Connect E_{max} on line 5 to E_{req} on line 13. Read allowable (continuous) exposure time in minutes on line 14.

*Corresponds to a body temperature rise of 2° F which is equivalent to a body heat gain of 250 BTU (considered to be a practical limit).

**At this point, the AET and MRT (minimum recovery time) can be calculated by the following relationships:

$$AET = \frac{250 \times 60}{E_{req} - E_{max}}$$

$$MRT = \frac{250 \times 60}{E_{max} - E_{req}} \text{ (conditions in rest area)}$$

HEAT EXCHANGE AND HUMAN TOLERANCE LIMITS

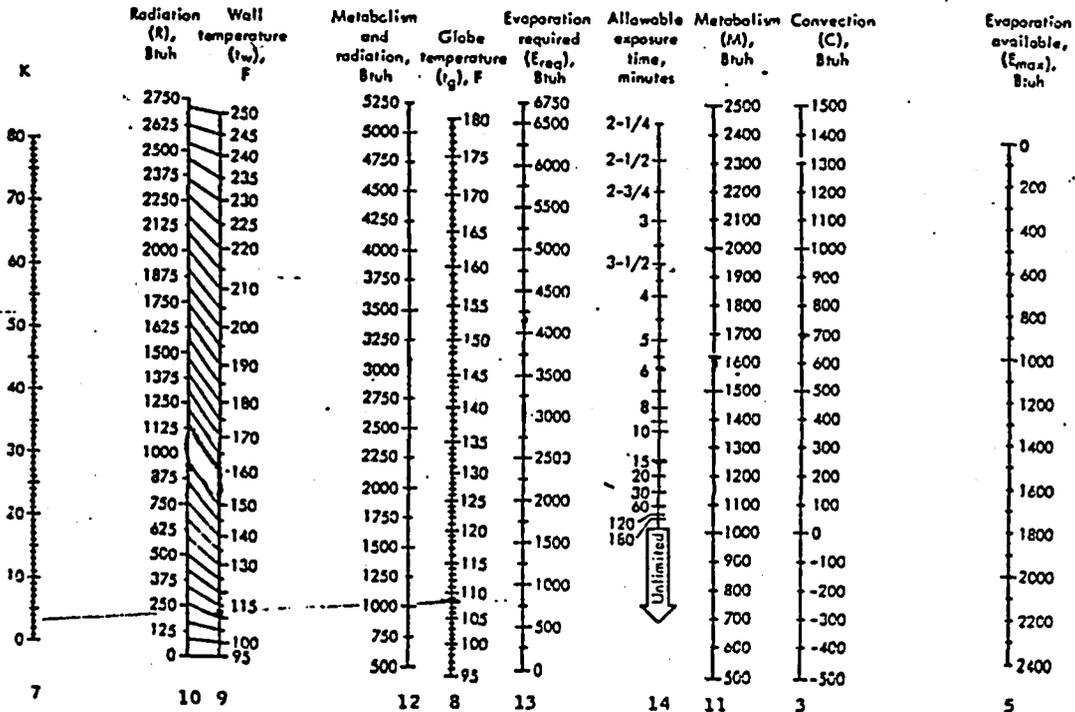
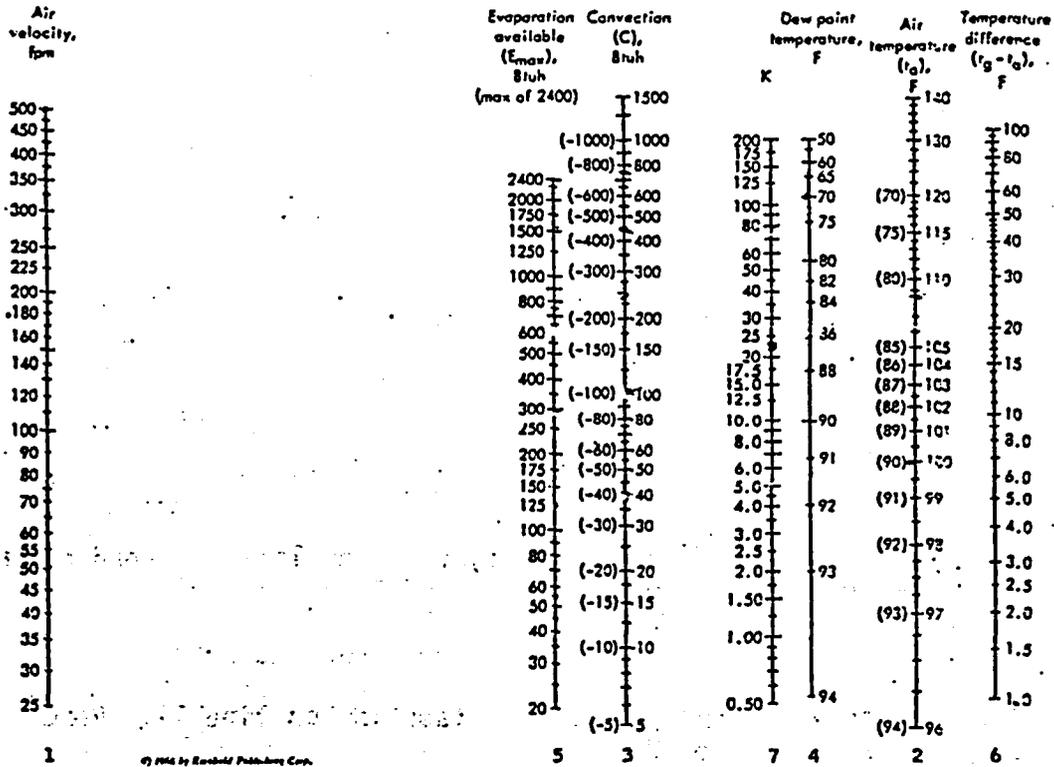


Figure 3—Evaluation of heat stress. Courtesy Reinhold Publishing Co.



RELATIVE HUMIDITY and DEW POINT TABLE

Pressure 30 Inches of Mercury

For use at elevations between 0 and 500 feet above sea level
 (In Alaska use at elevations between 0 and 300 feet above sea level)

HOW TO USE THE TABLE

Locate the wet bulb temperature in the headings which read horizontally from left to right at the top of the columns. Locate the dry bulb temperature in the columns which read vertically from top to bottom at the left side of the table. Follow down the column under the wet bulb temperature and across the line from the dry bulb temperature; at the intersection of the column and line will be found the relative humidity (%) in black, and the dew point (°F) in red.

DRY BULB TEMPERATURES

| | | | | | | | | | | | | | | | | |
|----|---|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 0 | | | | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | |

NOTE

This table was computed by use of the presently accepted psychrometric formulas. But at temperatures below 32°F the tables may and probably do depart significantly from physically-correct values. Vapor pressure over water, to which modern meteorological hygrometric tables are referred, is not known exactly at temperatures below the freezing point of water. The error is thought to be small near freezing and to grow to large proportions at very low temperatures. Furthermore the psychrometric equation itself is suspect at low temperatures. Because of (1) the difficulties of obtaining accurate wet and dry bulb readings at temperatures below 32°F, (2) the extreme sensitivity of tabular values to small differences in wet bulb depression at very low temperatures, and (3) other possible errors discussed above; the total error in psychrometrically derived dew points at 10°F and below may reach serious proportions.

Values in the body of the table are relative humidities (in percent) and dew points (in deg. Fahr.), with respect to water, for indicated values of wet and dry bulb temperatures in degrees Fahrenheit.

WET BULB TEMPERATURES

| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|----|---|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | |
| 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 23 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 26 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 29 | | | | | | | | | | | | | | | | | | | | | | | | | | | |

WET BULB TEMPERATURES

WET BULB TEMPERATURES

| | | | | | | | | | | | | | | | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--|
| | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | |
| 30 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 31 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 32 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 33 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 34 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 35 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 36 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 37 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 38 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 39 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 40 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 41 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 42 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 43 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 44 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 45 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 46 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 47 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 48 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 49 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 51 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 52 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 53 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 54 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 55 | | | | | | | | | | | | | | | | | | | | | | | | | | |

*Note: black = bottom number
 red = top number

DRY BULB TEMPERATURES

Table 4a

| | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|
| | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| 56 | | | | | | | | | | |
| 57 | | | | | | | | | | |
| 58 | | | | | | | | | | |
| 59 | | | | | | | | | | |
| 60 | | | | | | | | | | |

WET BULB TEMPERATURES

Table 4b

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|----|------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 |
| 63 | -2.3 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 64 | -2.4 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 65 | -2.5 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 66 | -2.6 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 67 | -2.7 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 68 | -2.8 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 69 | -2.9 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 70 | -3.0 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 71 | -3.1 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 72 | -3.2 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 73 | -3.3 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 74 | -3.4 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 75 | -3.5 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 76 | -3.6 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 77 | -3.7 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 78 | -3.8 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 79 | -3.9 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 80 | -4.0 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 81 | -4.1 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 82 | -4.2 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 83 | -4.3 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 84 | -4.4 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 85 | -4.5 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 86 | -4.6 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 87 | -4.7 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 88 | -4.8 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 89 | -4.9 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |
| 90 | -5.0 | 7 | 11 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 | 66 | 69 | 72 | 75 | 78 |

DRY BULB TEMPERATURES

WET BULB TEMPERATURES

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 91 | -3.4 | 1 | 5 | 9 | 13 | 17 | 21 | 25 | 29 | 33 | 37 | 41 | 45 | 49 | 53 | 57 | 61 | 65 | 69 | 73 | 77 | 81 | 85 | 89 | 93 | 97 | 101 | 105 | 109 | 113 | 117 | 121 | 125 | 129 | 133 | 137 | 141 | 145 | 149 | 153 | 157 | 161 | 165 | 169 | 173 | 177 | 181 | 185 | 189 | 193 | 197 | 201 | 205 | 209 | 213 | 217 | 221 | 225 | 229 | 233 | 237 | 241 | 245 | 249 | 253 | 257 | 261 | 265 | 269 | 273 | 277 | 281 | 285 | 289 | 293 | 297 | 301 | 305 | 309 | 313 | 317 | 321 | 325 | 329 | 333 | 337 | 341 | 345 | 349 | 353 | 357 | 361 | 365 | 369 | 373 | 377 | 381 | 385 | 389 | 393 | 397 | 401 | 405 | 409 | 413 | 417 | 421 | 425 | 429 | 433 | 437 | 441 | 445 | 449 | 453 | 457 | 461 | 465 | 469 | 473 | 477 | 481 | 485 | 489 | 493 | 497 | 501 | 505 | 509 | 513 | 517 | 521 | 525 | 529 | 533 | 537 | 541 | 545 | 549 | 553 | 557 | 561 | 565 | 569 | 573 | 577 | 581 | 585 | 589 | 593 | 597 | 601 | 605 | 609 | 613 | 617 | 621 | 625 | 629 | 633 | 637 | 641 | 645 | 649 | 653 | 657 | 661 | 665 | 669 | 673 | 677 | 681 | 685 | 689 | 693 | 697 | 701 | 705 | 709 | 713 | 717 | 721 | 725 | 729 | 733 | 737 | 741 | 745 | 749 | 753 | 757 | 761 | 765 | 769 | 773 | 777 | 781 | 785 | 789 | 793 | 797 | 801 | 805 | 809 | 813 | 817 | 821 | 825 | 829 | 833 | 837 | 841 | 845 | 849 | 853 | 857 | 861 | 865 | 869 | 873 | 877 | 881 | 885 | 889 | 893 | 897 | 901 | 905 | 909 | 913 | 917 | 921 | 925 | 929 | 933 | 937 | 941 | 945 | 949 | 953 | 957 | 961 | 965 | 969 | 973 | 977 | 981 | 985 | 989 | 993 | 997 | 1001 | 1005 | 1009 | 1013 | 1017 | 1021 | 1025 | 1029 | 1033 | 1037 | 1041 | 1045 | 1049 | 1053 | 1057 | 1061 | 1065 | 1069 | 1073 | 1077 | 1081 | 1085 | 1089 | 1093 | 1097 | 1101 | 1105 | 1109 | 1113 | 1117 | 1121 | 1125 | 1129 | 1133 | 1137 | 1141 | 1145 | 1149 | 1153 | 1157 | 1161 | 1165 | 1169 | 1173 | 1177 | 1181 | 1185 | 1189 | 1193 | 1197 | 1201 | 1205 | 1209 | 1213 | 1217 | 1221 | 1225 | 1229 | 1233 | 1237 | 1241 | 1245 | 1249 | 1253 | 1257 | 1261 | 1265 | 1269 | 1273 | 1277 | 1281 | 1285 | 1289 | 1293 | 1297 | 1301 | 1305 | 1309 | 1313 | 1317 | 1321 | 1325 | 1329 | 1333 | 1337 | 1341 | 1345 | 1349 | 1353 | 1357 | 1361 | 1365 | 1369 | 1373 | 1377 | 1381 | 1385 | 1389 | 1393 | 1397 | 1401 | 1405 | 1409 | 1413 | 1417 | 1421 | 1425 | 1429 | 1433 | 1437 | 1441 | 1445 | 1449 | 1453 | 1457 | 1461 | 1465 | 1469 | 1473 | 1477 | 1481 | 1485 | 1489 | 1493 | 1497 | 1501 | 1505 | 1509 | 1513 | 1517 | 1521 | 1525 | 1529 | 1533 | 1537 | 1541 | 1545 | 1549 | 1553 | 1557 | 1561 | 1565 | 1569 | 1573 | 1577 | 1581 | 1585 | 1589 | 1593 | 1597 | 1601 | 1605 | 1609 | 1613 | 1617 | 1621 | 1625 | 1629 | 1633 | 1637 | 1641 | 1645 | 1649 | 1653 | 1657 | 1661 | 1665 | 1669 | 1673 | 1677 | 1681 | 1685 | 1689 | 1693 | 1697 | 1701 | 1705 | 1709 | 1713 | 1717 | 1721 | 1725 | 1729 | 1733 | 1737 | 1741 | 1745 | 1749 | 1753 | 1757 | 1761 | 1765 | 1769 | 1773 | 1777 | 1781 | 1785 | 1789 | 1793 | 1797 | 1801 | 1805 | 1809 | 1813 | 1817 | 1821 | 1825 | 1829 | 1833 | 1837 | 1841 | 1845 | 1849 | 1853 | 1857 | 1861 | 1865 | 1869 | 1873 | 1877 | 1881 | 1885 | 1889 | 1893 | 1897 | 1901 | 1905 | 1909 | 1913 | 1917 | 1921 | 1925 | 1929 | 1933 | 1937 | 1941 | 1945 | 1949 | 1953 | 1957 | 1961 | 1965 | 1969 | 1973 | 1977 | 1981 | 1985 | 1989 | 1993 | 1997 | 2001 | 2005 | 2009 | 2013 | 2017 | 2021 | 2025 | 2029 | 2033 | 2037 | 2041 | 2045 | 2049 | 2053 | 2057 | 2061 | 2065 | 2069 | 2073 | 2077 | 2081 | 2085 | 2089 | 2093 | 2097 | 2101 | 2105 | 2109 | 2113 | 2117 | 2121 | 2125 | 2129 | 2133 | 2137 | 2141 | 2145 | 2149 | 2153 | 2157 | 2161 | 2165 | 2169 | 2173 | 2177 | 2181 | 2185 | 2189 | 2193 | 2197 | 2201 | 2205 | 2209 | 2213 | 2217 | 2221 | 2225 | 2229 | 2233 | 2237 | 2241 | 2245 | 2249 | 2253 | 2257 | 2261 | 2265 | 2269 | 2273 | 2277 | 2281 | 2285 | 2289 | 2293 | 2297 | 2301 | 2305 | 2309 | 2313 | 2317 | 2321 | 2325 | 2329 | 2333 | 2337 | 2341 | 2345 | 2349 | 2353 | 2357 | 2361 | 2365 | 2369 | 2373 | 2377 | 2381 | 2385 | 2389 | 2393 | 2397 | 2401 | 2405 | 2409 | 2413 | 2417 | 2421 | 2425 | 2429 | 2433 | 2437 | 2441 | 2445 | 2449 | 2453 | 2457 | 2461 | 2465 | 2469 | 2473 | 2477 | 2481 | 2485 | 2489 | 2493 | 2497 | 2501 | 2505 | 2509 | 2513 | 2517 | 2521 | 2525 | 2529 | 2533 | 2537 | 2541 | 2545 | 2549 | 2553 | 2557 | 2561 | 2565 | 2569 | 2573 | 2577 | 2581 | 2585 | 2589 | 2593 | 2597 | 2601 | 2605 | 2609 | 2613 | 2617 | 2621 | 2625 | 2629 | 2633 | 2637 | 2641 | 2645 | 2649 | 2653 | 2657 | 2661 | 2665 | 2669 | 2673 | 2677 | 2681 | 2685 | 2689 | 2693 | 2697 | 2701 | 2705 | 2709 | 2713 | 2717 | 2721 | 2725 | 2729 | 2733 | 2737 | 2741 | 2745 | 2749 | 2753 | 2757 | 2761 | 2765 | 2769 | 2773 | 2777 | 2781 | 2785 | 2789 | 2793 | 2797 | 2801 | 2805 | 2809 | 2813 | 2817 | 2821 | 2825 | 2829 | 2833 | 2837 | 2841 | 2845 | 2849 | 2853 | 2857 | 286 |

TABLE 5
HEAT STRESS CONTROLS

| Item | Possible Actions |
|--|---|
| Heat Components: Metabolism | Reduce by: Mechanization of some or all tasks. Sharing work load with others (particularly during peak heat periods). Increasing rest time. |
| Radiation | Reduce by: Minimizing line-of-sight to source. Insulating furnace walls. Using reflective screens. Wearing reflective aprons (particularly valuable when workers face source). Covering exposed parts of body. |
| Convection Above 95 F | Reduce by: Lowering air temperature. Lowering air velocity. Wearing clothing. |
| Below 95 F | Reduce by: Lowering air temperature. Increasing air velocity. Removing clothing. |
| Evaporation available (E_{max}) | Increase by: Increasing air velocity. Decreasing humidity. |
| Work Schedule: Duration | Shorten duration of each exposure. Use more frequent rest periods. |
| Recovery | Use nearby air conditioned space fo rest area. Adjust V in rest area for effective cooling. |
| Other | Allow worker to self-limit exposure on basis of signs and symptoms of heat strain. Provide cool, potable water containing 0.1% salt. |
| Clothing | For extreme conditions, use cooled (by vortex tube or other means) clothing. Wear type of clothing to obtain $E_{max} > E_{req}$ with minimum sweating. |

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REQUEST FOR ASSISTANCE

NAME OF COMPANY: _____

COMPANY ADDRESS: _____ (City) _____

INDIVIDUAL TO CONTACT: _____ TITLE: _____

TELEPHONE NO.: _____ TYPE INDUSTRY: _____

REQUEST: _____ CONSULTING SERVICE _____ SAFETY TRAINING PROGRAM
 _____ OSHA SEMINAR _____ ANSWER SPECIFIC QUESTIONS
 _____ OSHA STANDARD* _____ FOLLOWING OSHA INSPECTIONS
 _____ EXTENSION OF ABATEMENT _____ ARRANGE INFORMAL CONFERENCES
 _____ DATES _____ ANSWER SPECIFIC QUESTIONS ON
 _____ RECORDKEEPING INFORMATION _____ OSHA STANDARDS
 *There is a charge for 1910 and 1926 OSHA Standards.

ADDITIONAL DETAILS AND COMMENTS:

 (Signature)

 (Date)

NORTH CAROLINA DEPARTMENT OF LABOR
 OCCUPATIONAL SAFETY & HEALTH ADMINISTRATION
 P. O. Box 27407, Raleigh, North Carolina 27611

John C. Brooks
 Commissioner

SAFETY SERVICES & CONTACTS

| <u>SERVICE</u> | <u>DESCRIPTION</u> | <u>NAME</u> | <u>TELEPHONE NO.</u> |
|--|---|---|----------------------|
| Education and Training | <ul style="list-style-type: none"> ● Safety Training Information ● Safety Meetings & Seminars ● OSHA-NC Bulletin ● Publications | George Jones | 919/733-4880 |
| Consultative Services | <ul style="list-style-type: none"> ● Answer OSHA Questions Concerning Compliance ● Visit Plant Sites ● Prepare Voluntary Compliance Programs ● Help Establish Safety Programs for Small Employers | Jim Dudley | 919/733-4880 |
| Standards and Inspections | <ul style="list-style-type: none"> ● Answer Specific Questions following OSHA Inspections ● Request Extension of Abatement Dates ● Arrange Informal Conference | Greg Coulson | 919/733-4880 |
| Safety and Health Engineering | <ul style="list-style-type: none"> ● Technical Assistance for Methods of Abatement or Compliance ● Interpretation of Standards ● Variances | Mike Peeler | 919/733-4880 |
| Industrial Hygiene Consultative Services | <ul style="list-style-type: none"> ● Provide Assistance for Health Programs ● Plant Surveys to Determine Health Hazards ● Suggestions for Engineering Controls | John Lumsden (Dept. of Human Resources, Occupational Health) | 919/733-3680 |