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ABSTRACT

This packet of six learning modules on safety is one of 20 such packets developed for apprenticeship training for stationary engineers. Introductory materials are a complete listing of all available modules and a supplementary reference list. Each module contains some or all of these components: goal, performance indicators, study guide (a checklist of steps the student should complete), an introduction, information sheets, a vocabulary list, assignment sheet, job sheet, self-assessment, self-assessment answers, post-assessment, and instructor post-assessment answers. The six training modules cover general safety, hand tool safety, power tool safety, fire safety, hygiene safety, and safety and electricity. (YLB)

APPRENTICESHIP

STATIONARY ENGINEERS

RELATED
TRAINING MODULES

2.1 - 2.6 SAFETY

STATEMENT OF ASSURANCE

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STATEMENT OF DEVELOPMENT

THIS PROJECT WAS DEVELOPED AND PRODUCED UNDER A SUB-CONTRACT FOR THE OREGON DEPARTMENT OF EDUCATION BY LANE COMMUNITY COLLEGE, APPRENTICESHIP DIVISION, EUGENE, OREGON, 1984.

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APPRENTICESHIP

STATIONARY ENGINEERS
RELATED TRAINING MODULES

COMPUTERS

1.1 Digital Language
1.2 Digital Logic
1.3 Computer Overview
1.4 Computer Software

SAFETY

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2.2 Hand Tool Safety
2.3 Power Tool Safety
2.4 Fire Safety
2.5 Hygiene Safety
2.6 Safety and Electricity

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MACHINE COMPONENTS

LUBRICATION

BOILERS

PUMPS

STEAM

TURBINES

STATIONARY ENGINEER
SUPPLEMENTARY REFERENCE DIRECTORY

Note: All reference packets are numbered on the upper right-hand corner of the respective cover page.

Supplementary Packet #	Description	Related Training Module
12.1	Correspondence Course, Lecture 1, Sec. 2, Steam Generators, Types of Boilers I, S.A.I.T., Calgary, Alberta, Canada	12.1 Boilers, Fire Tube Type
12.2	Correspondence Course, Lecture 2, Sec. 2, Steam Generators, Types of Boilers II, S.A.I.T., Calgary, Alberta, Canada	12.2 Boilers, Water Tube Type
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12.4	Correspondence Course, Lecture 4, Sec. 2, Steam Generators, Boiler Fittings II, S.A.I.T., Calgary, Alberta, Canada	12.4 Boilers, Fittings
12.4	Corresondence Course, Lecture 4, Sec. 2, Steam Generators, Boiler Fitting I, S.A.I.T., Calgary, Alberta, Canada	12.4 Boilers, Fittings
12.5	Correspondence Course, Lecture 10, Sec. 2, Steam Generation, Boiler Operation, Maintenance, Inspection, S.A.I.T., Calgary, Alberta, Canada	12.5 Boilers, Operation
12.7	Correspondence Course, Lecture 3, Sec. 2, Steam Generation, Boiler Details, S.A.I.T., Calgary, Alberta, Canada	12.7 Boilers Heat Recovery Systems
12.8	Refer to reference packet 14.3/12.8	
		PUMPS
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13.2		13.2 Applications
13.4		13.4 Calculating Heat & Flow
13.6		13.6 Monitoring & Troubleshooting
13.7		13.7 Maintenance
13.3	Correspondence Course, Lecture 6, Sec. 3, Steam Generators, Pumps, S.A.I.T., Calgary, Alberta, Canada	13.3 Construction
13.5		13.5 Operation

Supplementary Packet #	Description	Related Training Module
14.3 12.8	Correspondence Course, Lecture 6, Section 3, Steam Generators, Steam Generator Controls, S.A.I.T., Calgary, Alberta, Canada	14.3 Steam, Transport 12.8 Boilers, Instruments & Controls
14.4	Correspondence Course, Lecture 11, Section 2, Steam Generators, Piping II, S.A.I.T., Calgary, Alberta, Canada	14.4 Steam, Purification
15.1	Correspondence Course, Lecture 1, Sec. 4, Prime Movers & Auxiliaries, Steam Turbines, S.A.I.T., Calgary, Alberta, Canada	15.1 Steam Turbines, Types
15.2	Correspondence Course, Lecture 4, Sec. 3, Prime Movers, Steam Turbines I, S.A.I.T., Calgary, Alberta, Canada	15.2 Steam Turbines, Components
15.3	Correspondence Course, Lecture 2, Sec. 4, Prime Movers & Auxiliaries, Steam Turbine Auxiliaries, S.A.I.T., Calgary, Alberta, Canada	15.3 Steam Turbines, Auxiliaries
15.4	Correspondence Course, Lecture 6, Sec. 3, Prime Movers, Steam Turbine Operation & Maintenance, S.A.I.T., Calgary, Alberta, Canada	15.4 Steam Turbines, Operation & Maintenance
15.5	Correspondence Course, Lecture 8, Sec. 3, Prime Movers, Gas Turbines, S.A.I.T., Calgary, Alberta, Canada	15.5 Gas Turbines
16.2	Boilers Fired with Wood and Bark Residues, D.D. Junge, F.R.L., O.S.U. 1975	16.2 Combustion Types of Fuel
16.2	Correspondence Course, Lecture 5, Sec. 2, Steam Generators, Fuel Combustion, S.A.I.T., Calgary, Alberta, Canada	16.2 Combustion Types of Fuel
16.3	Correspondence Course, Lecture 5, Sec. 2, Plant Services, Fuel & Combustion, S.A.I.T., Calgary, Alberta, Canada.	16.3 Combustion, Air & Fuel Gases
17.1	Correspondence Course, Lecture 12, Sec. 3, Steam Generation, Water Treatment, S.A.I.T., Calgary, Alberta, Canada	17.1 Feed water, Types & Operation
17.2	Correspondence Course, Lecture 12, Sec. 2, Steam Generation, Water Treatment, S.A.I.T., Calgary, Alberta, Canada	17.2 Feed water, Water Treatments

Supplementary Packet #	Description	Related Training Module
17.3	Correspondence Course, Lecture 7, Sec. 2, Steam Generators, Boiler Feed Water Treatment, S.A.I.T., Calgary, Alberta, Canada	17.3 Feed Water, Testing
18.1	Correspondence Course, Lecture 2, Sec. 5, Electricity, Direct Current Machines, S.A.I.T., Calgary, Alberta, Canada	18.1 Generators, Types & Construction
18.1 18.2	Correspondence Course, Lecture 4, Sec. 5, Electricity, Alternating Current Generators, S.A.I.T., Calgary, Alberta, Canada	18.1 Generators, Types & Construction 18.2 Generators, Operation
19.1	Corrspondence Course, Lecture 5, Sec. 4, Prime Movers & Auxiliaries, Air Compressor I, S.A.I.T., Calgary, Alberta, Canada	19.1 Air Compressors, Types
19.1 19.2	Correspondence Course, Lecture 6, Sec. 4, Prime Movers & Auxiliaries, Air Compressors II, S.A.I.T., Calgary, Alberta, Canada	19.1 Air Compressors, Types 19.2 Air Compressors, Operation & Maintenance
20.1	Basic Electronics, Power Transformers, EL-BE-51	20.1 Transformers
21.1	Correspondence Course, Lecture 7, Sec. 5, Electricity, Switchgear & Circuit, Protective Equipment, S.A.I.T., Calgary, Alberta, Canada	21.1 Circuit Protection
22.1	Correspondence Course, Lecture 10, Sec. 3, Prime Movers, Power Plant Erection & Installation, S.A.I.T., Calgary, Alberta, Canada	22.1 Installation Foundations

RECOMMENDATIONS FOR USING TRAINING MODULES

The following pages list modules and their corresponding numbers for this particular apprenticeship trade. As related training classroom hours vary for different reasons throughout the state, we recommend that the individual apprenticeship committees divide the total packets to fit their individual class schedules.

There are over 130 modules available. Apprentices can complete the whole set by the end of their indentured apprenticeships. Some apprentices may already have knowledge and skills that are covered in particular modules. In those cases, perhaps credit could be granted for those subjects, allowing apprentcies to advance to the remaining modules.

We suggest the the apprenticeship instructors assign the modules in numerical order to make this learning tool most effective.

SUPPLEMENTARY INFORMATION

ON CASSETTE TAPES

Tape 1: Fire Tube Boilers - Water Tube Boilers and Boiler Manholes and Safety Precautions

Tape 2: Boiler Fittings, Valves, Injectors, Pumps and Steam Traps

Tape 3: Combustion, Boiler Care and Heat Transfer and Feed Water Types

Tape 4: Boiler Safety and Steam Turbines

NOTE: The above cassette tapes are intended as additional reference material for the respective modules, as indicated, and not designated as a required assignment.

2.1

GENERAL SAFETY

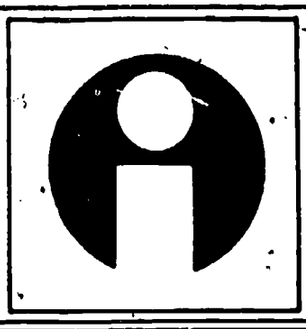
Goal:

The apprentice will be able to describe general safety procedures.

Performance Indicators:

1. Describe safety awareness.
2. Describe causes of accidents.
3. Describe unsafe acts.
4. Describe safety planning.

Study Guide



This study guide is to be used by the student as a "blueprint" to successfully complete this module. Please complete all of the following steps, and check them off as you complete them.

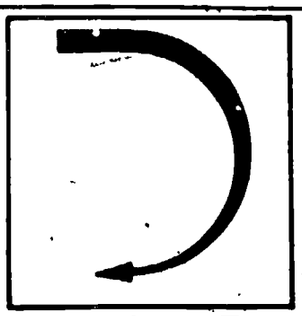
1. ____ Familiarize yourself with the Goal and Performance Indicators of this module. This will give you an overall view of what the module contains and what you'll have to do to complete it.

2. ____ Study the Information section thoroughly. This will provide you with the knowledge necessary to pass the exam.

3. ____ Take the Self Assessment Exam which follows the Information section. The exam is designed to determine whether you have learned enough from the Information section to sucessfully complete the Post Assessment exam. You may refer to the Information section for assistance, but if you have too much trouble on the Self Assessment portion, you should re-study the Information section before going to step 4. Compare your Self Assessment answers with those on the Self Assessment Answer Sheet following the Self Assessment exam.

4. ____ Complete the Post Assessment Exam and turn it in to your instructor for grading. It is recommended that you score 90% or better on the Post Assessment before going on to the next module.

Introduction



GENERAL SAFETY

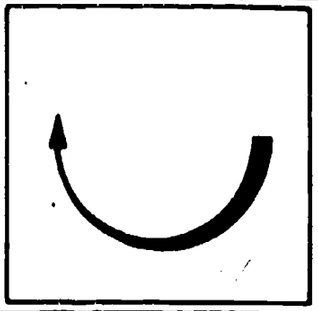
THE IMPORTANCE OF SAFETY

Employees owe it to themselves, their families, their co-workers, and their employers to work in the safest manner. Unless safety principles and practices are faithfully observed every day, the time and effort an apprentice puts forth in learning a trade could become a tragic waste. Taking the time now to learn about job safety can mean the difference between life and death or between living a normal, productive life and having to struggle for a decent living as a result of a physical handicap.

By their very nature, occupations within the construction industry are extremely hazardous, and an employer or an employee who lacks concern for on-the-job safety contributes toward an increased possibility of accident or death on the job.

This topic and those that follow on safety are designed to help apprentices become aware of some of the hazards of the trade, to help them become safety minded, and to enable them to use their reasoning powers to recognize dangerous situations.

Information



For the past several years, the number of employees killed has averaged 14,200 a year. From 1960 through 1970 there were over 150,000 fatalities. In 1972, more than 50 million employee-days were lost because of disabling injuries, and the known cost of accidents--not counting property damage--was over $11.5 billion. Unknown costs, resulting directly from accidents but not recorded, or not possible to record, are several times higher. These figures do not include most of the deaths and disabling illnesses from occupational disease. Most of these were not recorded before enactment of the Williams-Steiger (OSHA) Act of 1970.

Recently, employers, unions, employees, and various government agencies have seen the need for developing effective programs to improve occupational safety and health. The importance of keeping employees safe and healthy has achieved such wide-spread recognition that a broad and detailed national program finally has emerged.

Everyone is beginning to realize there is an obligation to protect individuals from on-the-job accidents and illnesses.

While more than 50 million employee days were lost in 1972, it's obvious that great losses in employee productivity, not to mention the 14,000 employees killed, were recorded. For example, it would take 188,000 men working for one year, five days a week, eight hours a day, with no vacations or time off, to make up for this lost time. These figures point out that too many employees are disabled form industrial accidents. However, many disabling injuries can be prevented.

It is impossible to put a dollar value on the tremendous wasted ability and contribution lost to society because of the death or disability of a fellow human.

CAUSES OF ACCIDENTS

An accident is an unplanned and unforeseen occurence that interferes with or interrupts the orderly progress of an activity. Although by this definition

accidents do not necessarily involve injury or death, in fact they all too often do. Accidents that do occur should be analyzed to determine why and how they occurred and to determine what steps should be taken to ensure that similar accidents do not occur again. Accidents are caused for the most part by unsafe conditions, unsafe acts, or some combination of these two hazards.

Unsafe conditions on the job site may be present in the form of equipment that is poorly designed or constructed, improperly installed, or badly maintained. Unguarded equipment, defective or wrong hand tools, poor housekeeping, and inadequate lighting are common factors that make for unsafe working conditions.

UNSAFE ACTS

Unsafe acts are violations of safe working practices. Wearing loose-fitting clothing on the job, operating machinery without the required guards or improperly throwing instead of carrying materials, lifting or carrying with the back bent, and engaging in horseplay on the job are all examples of unsafe acts.

Unsafe conditions and unsafe acts are both threats to the worker's safety, but the majority of industrial accidents are caused by a combination of these hazards. A wheelbarrow with cracked or loose handles (unsafe condition) may not play a part in an accident until a worker attempts to move a heavy, unbalanced load in it (unsafe act). A power saw with an unguarded blade is not likely in itself to cause an accident, but a severe injury can result if a worker disregards the unsafe condition of the machine and as a result gets his hand in the way of the blade.

PREJOB SAFETY PLANNING

Although a great deal of time and money have been spent by safety-oriented organizations to improve accident-prevention efforts on the job site, prejob planning continues to be of the utmost importance in providing for the safety of those involved with a construction project. This planning is a cooperative effort and demands the participation of the contractor, the union representative, and the workers. During the prejob planning, an attempt is made to establish rules for safety on the particular project, to anticipate problems that could arise, and to determine appropriate methods for protecting the persons involved with the job and the job site.

In the decade of the 60's, a sharp increase of job related accidents occurred (29%). A wider use of new chemicals and hazardous materials created a greater source of unsafe conditions. Labor's concern for a safe workplace pushed for passage of legislation and in 1970 the Williams-Steiger bill was passed. You know it as OHSA, the Occupational Safety and Health Bill of 1970.

THE WILLIAMS-STEIGER OCCUPATIONAL SAFETY AND HEALTH ACT OF 1970

In passing the Williams-Steiger Occupational Safety and Health Act of 1970 (OSHA), the federal government declared safety on the job to be everyones responsibility. The purpose of OSHA, which became effective in 1971, is to preserve human resources and to ensure so far as possible that every worker in the nation will have safe and healthful working conditions. This law applies to all states and U.S. territories, but it provides that the states may develop their own plans for meeting the requirements of the law.

RESPONSIBILITY OF EMPLOYERS

The Williams-Steiger Act requires that every employer furnish his employees a place of employment that is free from recognized hazards that might cause serious injury or death. The act further requires that employers comply with the specific safety and health standards issued by the U.S. Department of Labor.

RESPONSIBILITY OF EMPLOYEES

In accordance with the provisions of the Williams-Steiger Act, all employees must comply with safety and health standards, rules, regulations, and orders issued under the act and applicable to their personal conduct.

ADMINISTRATION OF THE WILLIAMS-STEIGER ACT

The administration and enforcement of OSHA are vested primarily in the Secretary of Labor and the New Occupational Safety and Health Review Commission. The basic purpose of the Act is "to assure, as far as possible, every working man and woman in the nation safe and healthful working conditions and to preserve our human resources." The "safe and healthful working conditions" will be assured by authorizing enforcement of the standards developed under the Act. Assisting and encouraging the states in their efforts to assure safe and healthful working conditions and providing for research, information, education, and training in the field of occupational safety and health are also intents of the Act.

OSHA covers about 60,000,000 people in 5,000,000 workplaces; excludes Federal employees, State and political subdivisions thereof and certain waterfront workers.

APPRENTICESHIP AND SAFETY

A major goal of all apprenticeship programs is to provide the apprentice with the knowledge and skills needed to work safely in his or her trade. Much time, effort, and money will be devoted to making an apprentice a skilled craftworker, all of which will be wasted if an industrial accident cuts short the apprentice's career and perhaps, life.

Apprentices are expected to learn how to work safely; to study the laws governing safety; to understand the principles upon which safe work practices are based; and to conduct themselves at all times with due consideration for their own safety and that of their co-workers.

The apprentice should keep in mind that accidents do not just happen. Accidents are caused by people, and they happen most often to people who fail to work in a safe manner.

VOCABULARY

Terms and Definitions

A. OSHAct--An abbreviation for the Occupational Safety and Health Act of 1970. The Act provides for minimum safety and health standards for working conditions. It is a Federal Act of Congress.

B. OSHA--An abbreviation for the Occupational Safety and Health Administration. OSHA is part of the United States Department of Labor and its main duties are to:

1. Encourage employers and employees to reduce hazards in their workplaces.
2. Establish responsibilities and rights of employers and employees.
3. Encourage new safety and health programs.
4. Establish record keeping procedures to keep track of injuries and illnesses that happen on/or because of the job.
5. Develop standards and enforce them.
6. Encourage the states to establish safety and health programs.

C. Standards--These are the rules that are set up by OSHA to provide minimum assurance of on-the-job safety. We will be concerned mainly with construction standards. There are two types of standards:

1. Horizontal standards - those applying to all industries.
2. Vertical standards - those applying to one special industry.

D. Variance--This is an exemption for an employer from a particular standard. There are several types of variances:

1. Temporary - when a standard cannot be complied with so other arrangements are made for the time being.
2. Permanent - when a means different from the standard provides adequate safety and health conditions.
3. Experimental - when testing new methods of safety.
4. Other - when there is a national emergency situation.

E. Accident--An unplanned, uncontrolled event which results in personal injury or the chance of personal injury. Accidents cost the U.S. at least $47 billion a year. Of this, $16 billion is due to accidents at work. Work accidents kill more than 12,000 people and cause over 2,000,000 disabling injuries per year in the U.S.

F. Hazard--Something that is potentially dangerous and if not corrected could cause an accident.

G. Contractor--An employer in construction. There are two types:

1. Prime or general contractor - the contractor in charge of the entire construction project and all of its phases. He or she is responsible for the overall safety and health of everyone working.

2. Sub-contractor - a contractor who works for the prime or general contractor and is responsible for some phase of the project such as pluming or painting. Each sub-contractor is responsible for the safety and health of his/her own employees.

H. Safety Director--The person responsible for putting a good safety program to work and keeping it running effectively on a company-wide basis. In large companies there may be a full-time safety director, while in small companies the superintendent or the contractor may act as the safety director along with his or her other duties.

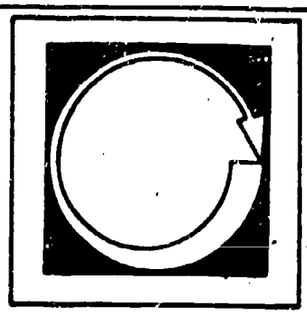
I. Project Superintendent--The person in charge of the entire project, usually reporting to the prime contractor. This person is responsible for putting the safety program to work on the project and making sure the workers follow it.

J. Safety Supervisor--On large projects there may be a full-time person who is assigned by the superintendent to run the safety program, including inspections, investigations, and record keeping.

K. Foreman--The person in charge of a small group of employees. He or she is usually very experienced in her or his trade.

L. Employee--Anyone who works for a contractor or is working on the job site. (TM 10- 1)

Self Assessment



Determine the correct word(s) for each statement and fill in the blanks.

1. Accidents are caused for the most part by unsafe _____, unsafe _____, or a combination of these hazards.

2. In passing the Williams-Steiger Occupational Safety and Health Act of 1970, the federal government declared that on-the-job safety is the responsibility of _____.

3. The responsibility for administering the Williams-Steiger Act rests with the Secretary of _____.

4. Anyone known to be under the influence of _____ _____ should not be permitted on the job while in that condition.

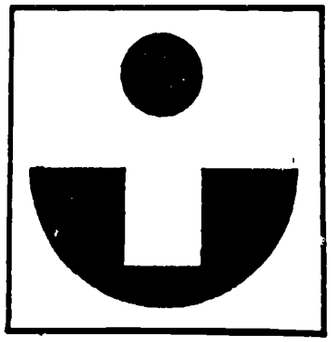
5. Employees should be alert to see that all guards and other protective devices are in their proper places and adjusted, and they should report any deficiencies to the _____ or _____.

6. Repairs or adjustments to machinery should not be made while the equipment is in _____.

7. A worker whose regular duties do not include operating machinery or equipment should not attempt to do so without special _____.

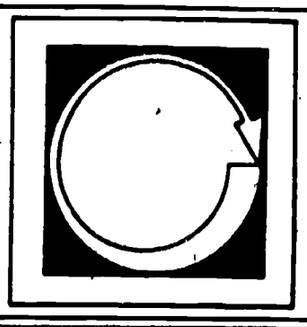
8. An accident is an _____ and _____ occurrence.

Self Assessment Answers



1. conditions, acts
2. everyone
3. labor
4. intoxicants, drugs
5. foreman, safety supervisor
6. motion
7. permission
8. unplanned, unforeseen

Post Assessment



Decide which of the four answers is correct, or most nearly correct; write the corresponding letter in the blanks at the left of each question.

1. ____ Provisions of the Williams-Steiger Occupational Safety and Health Act of 1970 require that employers comply with safety and health standards issued by the

   a. U.S. Senate
   b. Division of Industrial Safety
   c. U.S. Department of Labor
   d. none of the above

2. ____ Workmen's compensation laws havebeen passed so that workers injured on the job may receive benefit payments

   a. only if the injury was the employer's fault
   b. only if the injury was the employee's fault
   c. if insured through an authorized insurance carrier
   d. in the case of any industrial injury

3. ____ In the lifting of loads, the weight should be carried mostly by the muscles in the

   a. legs
   b. back
   c. arms
   d. abdomen

4. ____ A good program of accident control must include

   a. offering rehabilitation training to injured workers
   b. firing employees who have accidents
   c. correcting unsafe working conditions and practices
   d. putting up safety posters

5. ____ Which of the following is an unsafe act?

   a. sawdust on a stairwell
   b. a ladder with a broken rung
   c. wearing loose-fitting clothing on the job
   d. poor housekeeping

6. ____ OSHA is a result of

   a. expanding federal government
   b. a decision by construction foremen
   c. the safety and health review committee
   d. labor's concern for a safe workplace

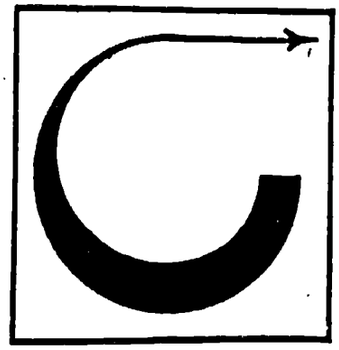
7. ____ During a typical year, in the past few years, the number of employees killed was near

   a. 200
   b. 750
   c. 12,000
   d. 100,000

8. ____ Which of the following is not a variance?

   a. temporary
   b. horizontal
   c. experimental
   d. permanent

Instructor Post Assessment Answers



1. d
2. d
3. a
4. c
5. c
6. d
7. c
8. b

INSTRUCTIONAL LEARNING SYSTEMS

2.2

HAND TOOL SAFETY

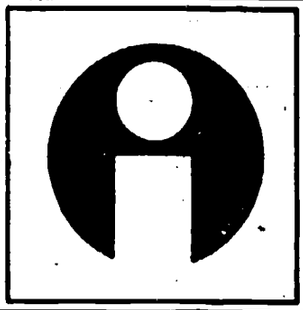
Goal:

The apprentice will be able to describe safety practices for the use of hand tools.

Performance Indicators:

1. Describe safe practices for use of common hand tools.

Study Guide



This study guide is to be used by the student as a "blueprint" to sucessfully complete this module. Please complete all of the following steps, and check them off as you complete them.

1. ____ Familiarize yourself with the Goal and Performance Indicators of this module. This will give you an overall view of what the module contains and what you'll have to do to complete it.

2. ____ Study the Information section thoroughly. This will provide you with the knowlege necessary to pass the exam.

3. ____ As stated in the Performance Indicators on the cover sheet of this module, you may be examined in one of two ways: 1) by taking the Self Assessment and Post Assessment exams or 2) by completing the Assignment as explained on the Assignment sheet.

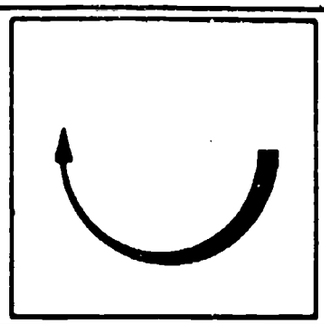
   a. ____ Complete the Assignment; your instructor will evaluate your performance.

   or

   b. ____ Take the Self Assessment exam which follows the Assignment page. The exam is designed to determine whether you have learned enough from the Information section to successfully complete the Post Assessment exam. You may refer to the Information section for assistance, but if you have too much trouble with the Self Assessment, you should re-study the Information section before going on to the next step. Compare your Self Assessment answers with those on the Self Assessment answer sheet which follows the exam.

   c. ____ Complete the Post Assessment exam and turn it in to your instructor for grading. It is recommended that you score 90% or better on the Post Assessment exam before going to the next module.

Information



This module, "Occupational Safety - Hand Tool Safety," covers the safety procedures for properly handling and maintaining the most common hand-powered tools formed in the most common work sites. Since the use of tools enables workers to carry out the most important functions of their jobs, each worker must know how to use his or her tools as safely and as efficiently as possible. Obviously, all tools should be kept clean and free of grease or other substances which might affect the grip of the worker or might impair the tools' efficiency. Likewise, tools should not be thrown. In addition to possible worker injury, the tool might be damaged, as well.

This and the following pages contain specific rules for good safety practice. The tools have been grouped into categories for easy reference.

A. HAMMER SAFETY: claw, ball peen, blacksmith's, bricklayer's, setting, riveting, engineer's, stone sledge, mash, and upholsterer's.
   1. Choose the correct type and size hammer for the job.
   2. The hammer face should be about 3/8" larger in diameter than the object being struck.
   3. Never strike two hammer faces together; the faces may chip off.
   4. Strike the object squarely and flatly to prevent slipping or denting.
   5. If the tool's handle is damaged replace the handle.
   6. If the hammer face is damaged or worn out replace the entire hammer.
   7. Use a sledge to drive hardened cut and masonry nails, not a claw or bricklayer's hammer. This can damage the faces of the latter two and may cause dangerous flying pieces.
   8. Do not use hammers on wooden or plastic handled chisels. Hammers will ruin these handles and may injure hands.
   9. Do not pound with the cheek (side) of the hammer. It can too easily slip off and also will damage the handle.

B. MALLET SAFETY: wood, plastic, rubber, rawhide, and nonferrous hammers such as lead, copper, aluminum, and brass.

1. Never use mallets for pounding on sharp objects or for driving nails. This will damage the soft heads.
2. Use mallets to pound on wood or plastic handled chisels to prevent damaging the chisels.
3. Do not use a mallet if the handle is loose, the head may fly off.

C. STRUCK TOOL SAFETY: cold chisels, all-steel wood chisels, drift punches and pins, star drills, blacksmith's punches, nail sets, wedges, brick sets and nail pullers.

1. Be sure struck tools are ground at the proper angles, are sharp and have no burns.
2. Remove mushroomed heads and properly dress the struck face to prevent flying pieces.
3. Replace worn out, cracked, or bent struck tools to prevent injuries.
4. Choose the correct struck tool for the job.
5. Hold the struck tools steady, but with a relaxed grip, so fingers or hands will not be hit. Use pliers or another tool if there is a hand injury hazard.
6. Tools being struck by other workers should be held with tongs.
7. Protect sharp edges when tools are stored, to prevent damaging them or cutting your hands or fingers.
8. Use a sledge, not a bricklayer's hammer, when hitting a brick set to prevent chipping the bricklayer's hammer face.

D. SCREWDRIVER SAFETY: regular, Phillips, Reed and Prince, and electrician's or cabinet in all their shapes and sizes.

1. Select the correct screwdriver for the job with the correct tip style and size, the correct length and shank, the correct handle size, smaller diameter for more speed, larger for more torque.
2. Never pound on a screwdriver. This will ruin the handle, damage the tip, and bend or break the shank.
3. Do not hold the screw with your hand while driving it, drill or punch a pilot hole to prevent hand or finger injuries.
4. Keep hands and fingers out from under the screwdriver to prevent gashes if it slips.
5. Screwdrivers should not be used as pry bars; this will bend or break the

shank and damage the tip.

6. Never use pliers to help turn a screwdriver, the job teeth will ruin the shank or handle.
7. Use an appropriate wrench only on heavy-duty, square-shanked screwdrivers.
8. Use a screw-holding clip or magnetized screwdriver to start screws in awkward places and to avoid hand or finger injury.
9. Use non-sparking screwdrivers, usually made of beryllium copper, when working near explosive vapors.
10. Use only properly insulated screwdrivers when working on electrical devices.
11. Do not use a screwdriver for electrical testing, this will burn or blast a piece out of it.
12. Do not use a screwdriver for stirring paint, varnish, or other materials that will leave a coating on it.

E. WRENCH SAFETY: open-end, box, socket, adjustable, pipe, monkey, chain, spanner, tee, torque, and Allen.

1. Select the right type of wrench for the job. Box and socket are usually the safest.
2. Select the correct size wrench for the job, considering fit and leverage needed. A snug fit is necessary. Don't use cheater bars as the force of the additional leverage will exceed what the wrench handle was designed to withstand.
3. Pull on adjustable wrenches, putting the force on the fixed jaw.
4. Be sure the wrench fits squarely on the object and is not tilted. This will help prevent slipping off or damage to the wrench and object.
5. Be sure your footing and your stance is adequate to prevent falling if something should let loose unexpectedly. Brace yourself if necessary.
6. Use a straight handle rather than an offset if possible, as there is less chance of slipping.
7. Never pound with a wrench.
8. Use penetrating oil on a frozen object first. If this does not loosen it, use a heavy-duty wrench that has a striking face (made to hit with a hammer).

F. PLIERS SAFETY: regular, slip-joint, pump, long nose, needle nose, side cutters, lineman's, crimpers, hose clamp, wire stripper and glass cutters.

1. Select the correct size and type for the job.
2. Never use a cheater on pliers as it can bend, break, and ruin them.
3. Do not expose pliers to excessive heat as it will draw the temper out.

4. When cutting, cut at right angles to the wire. This puts the least strain on the pliers.
5. Do not bend the wire back and forth against the cutting edges as it may damage the edges or spring the pliers.
6. When cutting, point the open side down so the cut end will not fly out at someone.
7. Put a drop of oil on the pliers joint to lengthen its life and allow for easier operation.
8. Use only pliers with high dielectric insulation (not just plastic-dipped ones) when working on electrical devices to prevent shocks or electrocution.
9. Keep jaw teeth or knurls clean to avoid slips and damage to material surface.
10. Never use pliers as a hammer.

G. VISE SAFETY: utility, machinist's, woodworker's, pipe and drill press.
1. When working on an object held in a vise, work as close to the vise as possible. This will help eliminate vibrations and chances for slipping.
2. Clamp objects in the middle of the jaw to prevent uneven strains on the vise.
3. Never use a cheater on a vise handle. This will bend the handle or ruin the screw.
4. Use a vise of adequate size. It is easy to ruin a vise by overloading it.
5. Be sure the vise is securely fastened to prevent it from falling off. Use all bolt holes and proper sized bolts.
6. Do not pound on vise jaws. They are hardened and may chip or crack.
7. Support the far end of long work to avoid putting excessive strain on the vise.
8. Repair or replace a damaged vise before using it.

H. CLAMPING TOOL SAFETY: bar, pipe, miter, spring, hand screw, "C", welder's, bank, and vise grips.
1. Select the correct size and type of clamp.
2. Keep all moving parts clean and lightly oiled to provide easy operation.
3. Do not over-tighten clamps and never use a cheater. This will bend, break, or ruin the threads.
4. Do not use clamps to secure scaffolding. If they are bumped they could let loose.
5. Never use clamps for hoisting materials. Use only approved devices.

I. SNIPS SAFETY: tin, aviation, combination, compound, lever, and shears.

1. Select the correct size and type snips for the job.
2. Keep snips sharp.
3. Do not cut wire with snips, it will damage the cutting edges. Use only on non-hardened sheet metal.
4. Use only hand pressure on the handles, never a hammer or your foot. This could spring the hinge.
5. Protect the edges and points of snips when stored to prevent injury and damage.
6. Wear gloves when cutting with snips.

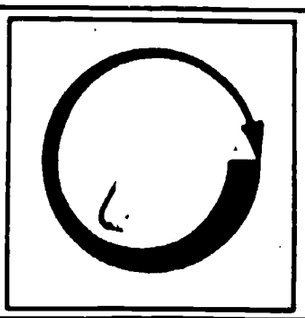
J. SAW SAFETY: hand saws, miter box, keyhole, compass, hack, back, dovetail, and coping.

1. Select the correct type and size saw for the job.
2. Keep saws sharp and set to insure good cutting.
3. Protect the points from being damaged by checking for nails, bolts or grit before sawing.
4. Use a saw-horse or bench, not your knee or leg to hold material when sawing.
5. Make sure saw handle is in good condition and tight.
6. Be aware of hand, finger, and leg position when sawing to prevent personal injury.
7. Wear gloves when sawing metal to prevent being cut by sharp cuttings.
8. Hacksaw teeth should point away from the handle and saw strokes directed away from yourself.

K. FILE AND RASP SAFETY: rough, coarse, bastard, second-cut, smooth and dead smooth metal files, cabinet files, wood rasps, other surform tools.

1. Select the proper type and size file for the job.
2. Do not confuse wood and metal files and rasps. Filing metal with a wood file or rasp will ruin it.
3. Cut on the forward stroke.
4. Clean files often while using to prevent slipping and to insure good cutting.
5. All files must have handles of proper size to prevent hand wounds.
6. Clamp objects to be filed securely to prevent filing your hand or fingers.
7. Never use files or rasps as pry bars, they are very hard and brittle and will snap, besides damaging the teeth.

Assignment



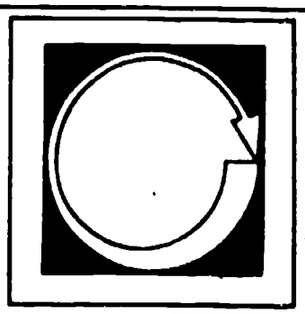
Select any two of the following three assignments to complete instead of taking the Self Assessment and Post Assessment exams.

1. Carry your tool box, kit or pouch to your instructor and demonstrate and tell him or her the proper use, the proper maintenance and the proper selection (what the tool is used for, as well as what it is not used for) for every tool you have. Explain the characteristics of each and point out any potential safety hazards which may exist on each tool.

2. Have your instructor improperly select and/or demonstrate the use of at least one tool from at least seven of the tool categories described in the Information section, while you point out what's wrong with the selection and/or use of each.

3. In your instructor's presence, compare your tools (or your employer's tools if you have access to them) with new tools of similar make, and describe any flaws, damage or improper maintenance which might make your tools unsafe.

Self Assessment



Select the answer which best completes the statement. Write the answer in the blank to the left of each statement.

1. ____ Hand tools should always:
   a. have a layer of grease to prevent rust during winter work
   b. have a layer of oil to prevent rust during winter work
   c. be kept clean of grease or oil at all times
   d. be covered with graphite during the winter

2. ____ The hammer face should be how much larger in diameter than the object being struck?
   a. 3/8"
   b. 5/8"
   c. 1" or more
   d. 1/16" only

3. ____ If a mallet handle is broken, you should always:
   a. tape the handle with non-ferrous tape
   b. glue and splice the handle
   c. heat the handle
   d. replace the handle

4. ____ The following is an example of a struck tool:
   a. star drill
   b. cresent wrench
   c. screwdriver
   d. needle nose pliers

5. ____ Tools being struck by others should be held with:
   a. gloves
   b. tongs
   c. cheater bars
   d. hoists

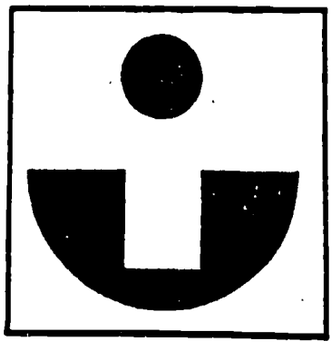
6. ____ On which type of screwdriver should a wrench be used?
   a. heavy-duty, square-shank
   b. star shanked titanium
   c. Phillips light weight
   d. none of the above

7. ____ Proper wrench safety always includes:
   a. oiling the handle
   b. tilting the wrench at an angle
   c. using an offset handle whenever possible
   d. using penetrating oil on frozen objects

8. ____ What type of cheater should be used with pliers?
   a. non-ferrous metal
   b. wood
   c. none
   d. spring steel

9. ____ When using a vise, objects should be clamped:
   a. at the near end of the jaw
   b. at the middle of the jaw
   c. wherever you want
   d. at the far end of the jaw

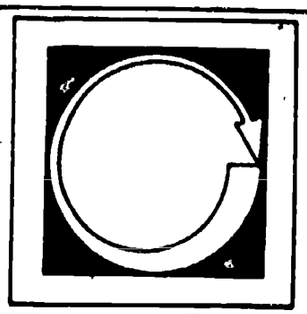
10. ____ Clamps should be:
   a. stored in a pile
   b. used for hoisting
   c. used for securing scaffolding
   d. tightened without the use of a cheater



Self Assessment Answers

1. c
2. a
3. d
4. a
5. b
6. a
7. d
8. c
9. b
10. d

Post Assessment



Select the answer which best completes the statement. Write your answer in the blank at the left of the statement.

1. ____ Snips may be used to cut:
   a. wire
   b. non-hardened sheet metal
   c. all lead alloys
   d. hardened sheet metal

2. ____ Hacksaw teeth should be:
   a. pointed toward your body
   b. pointed away from your body
   c. bent at both ends
   d. heated before cutting

3. ____ One characteristic of a file or rasp is it's:
   a. brittle
   b. soft
   c. springy
   d. silver coated

4. ____ When working on or near electrical devices, use only pliers with:
   a. high dielectric insulation
   b. low dielectric insulation
   c. circuit breakers
   d. plastic handles, shanks, tips and barrels

5. ____ A cheater bar provides for:
   a. more leverage
   b. less leverage
   c. less foot-pounds-per-square-inch
   d. C-clamps

6. ____ Wrenches should always be:
   a. pulled toward your body
   b. pushed away from your body
   c. owned by the contractor
   d. silver-plated

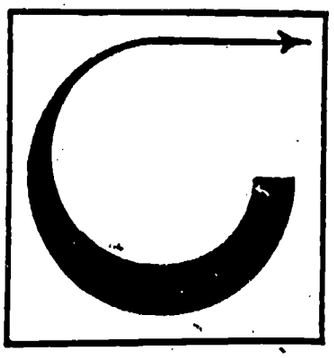
7. ____ Struck tools with mushroomed heads should be:
   a. repaired
   b. used as often as possible
   c. used in conjunction with a sledge hammer
   d. coated with plastic

8. ____ When working near explosive vapors, screwdrivers should be:
   a. made of beryllium copper
   b. made of non-ferrous metals
   c. stored in dry ice prior to use
   d. steel-coated

9. ____ When moving about the job site, tools should be:
   a. tossed
   b. thrown
   c. carried
   d. coated in plastic

10. ____ Wood rasps and files should always be:
   a. used on steel
   b. sharpened
   c. rubber-tipped
   d. clamped the object to be filed

Instructor Post Assessment Answers



1. b
2. b
3. a
4. a
5. a
6. a
7. a
8. a
9. c
10. d

2.3

POWER TOOL SAFETY

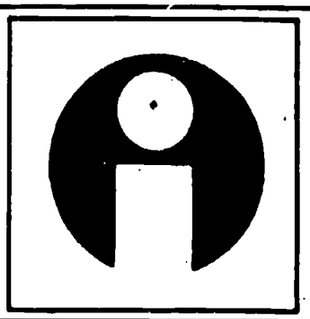
Goal:

The apprentice will be able to describe safe practices in the use of power tools.

Performance Indicators:

1. Describe safety with electric power tools.
2. Describe safety with pneumatic power tools.
3. Describe safety with hydraulic power tools.
4. Describe safety with power actuated power tools.
5. Describe safety with air compressors.

Study Guide



This study guide is to be used by the student as a "blueprint" to successfully complete this module. Please complete all of the following steps, and check them off as you complete them.

1. ____ Familiarize yourself with the Goals and Performance Indicators of this module. This will give you an overall view of what the module contains and what you'll have to do to complete it.

2. ____ Study the Information section thoroughly. This will provide you with the knowledge necessary to pass the exams.

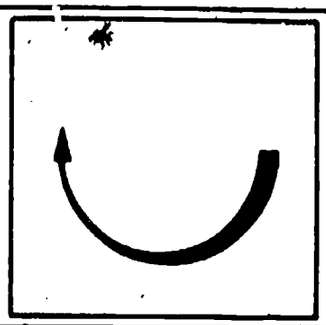
3. ____ Complete the Assignment as instructed on the Assignment page. The Assignment is intended not only to make you better aware of the principles discussed in the Information section, but it is intended to be part of the requirement for successfully completing the module.

4. ____ Take the Self-Assessment Exam which follows the Assignment page. The exam is designed to determine whether you have learned enough from the Information section and your assignment to successfully complete the Post Assessment exam.

   You may refer to the Information section for assistance, but if you have too much trouble with the Self-Assessment portion, you should re-study the Information section before going on to step 5. Compare your Self Assessment answers with those on the Self Assessment answer sheet immediately following the Self Assessment exam.

5. ____ Complete the Post Assessment exam and turn it in to your instructor for grading. It is recommended that you score 90% or better on the Post Assessment before going on to the next module.

Information



This module covers safety procedures for the most commonly-used electric, pneumatic, hydraulic and powder-actuated tools used in and around the construction industry. Many of the rules for operating these tools--as for the operation of hand tools--require only common sense. For example, every worker should know the following: electric tools must have grounding wires or insulated cases to prevent shock; electrical cords must be examined prior to use for insulation or prong damage; proper cord sizes should be used to prevent overheating and fires; plugs should be removed from receptacles carefully to avoid wire damage; switches should be in good operating condition and should be in "off" position before the cord is plugged in; adjust and clean power tools only when the tool is unplugged, and be cautious when plugging in a power cord for another worker.

ELECTRIC

PORTABLE CIRCULAR SAW SAFETY

1. Must be equipped with a fixed guard over the upper half of the blade and a working movable guard over the lower half.
2. Saw blade should clear the stock being cut by no more than 1/8 inch.
3. Use the recommended blade, the proper size, in good condition, and installed correctly.
4. Never block or tie the guard back.
5. Allow the saw to cut without forcing.
6. Check material to be cut for nails, grit, or any material that may interfere with cutting.
7. Always check for the lower guard return before putting the saw down.
8. Adequately support the material to be cut to prevent binding.
9. Allow the saw blade to come to full speed before cutting to prevent overloading and possible kickbacks.
10. Hold the saw firmly, do not allow it to pull out of your hands.
11. Saw in the forward motion only, never backwards.

12. Clean sawdust from around the movable guard often and before using to insure it works properly.
13. Do not over-reach.
14. Never try to cut a curve or other than in a straight line with a portable circular saw.

RECIPROCATING HAND SAWS

1. Select the proper blade for the material used and the cut to be made.
2. Hold the saw firmly.
3. When making a plunge cut, feed the blade in slowly with the base of the saw setting on the material.
4. Hold the base against the material being cut.

POWER HACKSAW SAFETY

1. Securely clamp stock to be sawed.
2. Turn the saw on and lower the blade on to the stock slowly.
3. Allow the saw to cut at its own rate.
4. Support long stock to prevent buckling.
5. Use the correct blade; make sure it is sharp, and mounted to cut on the power stroke. Use coolant if necessary.
6. Metal may be hot and have a sharp burr after being hacksawed.
7. Set blade tension at manufacturer's recommendation.

PNEUMATIC TOOL SAFETY

1. Pneumatic tool hoses must be secured to prevent accidental disconnection.
2. Compressed air can be used for cleaning only if pressure is less than 30 pounds per square inch (PSI) and it is used with an effective chip guard.
3. Any pneumatic hose over 1/2-inch in diameter must have a safety valve at the source that reduces pressure if the hose fails.
4. Couplings between hoses must have a safety connection in case the couplings fail to hold.
5. All pneumatic nailers with automatic feed and that operate with over 100 PSI pressure must have a safety device on the muzzle to prevent the nailer from ejecting when not in contact with the work surface. It is wise to have this feature on all nailers.
6. Never point a nailer or stapler at anyone. When carrying them, point them toward the floor.
7. Never use pneumatic hoses for hoisting anything.

8. Use a dryer and filter to prevent moisture and dirt from entering the tool.
9. Be sure hose and fittings are in good condition and securely fastened before opening the air-line valve.
10. Never exceed the manufacturer's recommended pressure for tools.
11. Wear proper personal protection when using pneumatic tools.
12. When work is completed, shut the air supply off and then run the tool to drain the line before disconnecting.

SPRAYER SAFETY

1. Do not exceed air pressure recommended by manufacturer. A blowup could occur.
2. When spraying, wear respiration protection and work in a well ventilated area only.
3. Never spray near ignition hazards.
4. Do not point the sprayer at anyone.

HYDRAULIC POWER TOOL SAFETY

1. Hydraulic fluid must be fire resistant and approved by the United States Bureau of Mines.
2. Never exceed the manufacturer's recommended safe operating pressure for hoses, pipes, fitting, filters, and controls.
3. Never touch a stream of hydraulic fluid from a leak. The fluid under pressure can cause serious injuries.

POWDER-ACTUATED TOOL SAFETY

1. Powder-actuated tools must be checked out and tested before loading each day. If not in good working order, they must not be used until repaired.
2. Do not load powder-actuated tools until just before using them.
3. Never point them at anyone, whether loaded or not.
4. Hearing and eye protection must be worn along with any other necessary personal protection.
5. Never allow hands or fingers in front of the open barrel end.
6. Never leave the tool unattended when using it, even if it is unloaded. Return it to its case and put away where unauthorized personnel cannot get it.
7. Leave protective guards in place.
8. There must be a safety device to prevent firing in case the tool is

dropped or while it is being loaded and unloaded.

9. There must be a safety device that prevents firing if the muzzle is tilted over eight degrees.
10. There must be a safety device that prevents the tool from firing unless the muzzle is pressed against the material surface.
11. Use low velocity piston type tools whenever possible.
12. Only those trained and qualified by an authorized dealer or distributor should be allowed to use powder-actuated tools.
13. Do not use powder-actuated tools where there is a combustion or explosion hazard.

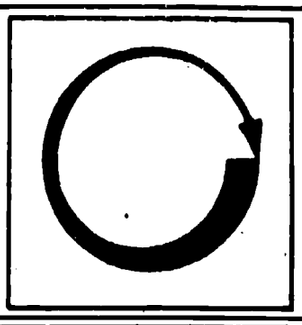
FASTENER (STUD GUN) SAFETY

1. Do not drive fasteners into very hard or brittle materials such as:
   a. Cast iron
   b. Glazed tile
   c. Surfaced hardened steel
   d. Glass block
   e. Face brick
   f. Hollow tile

COMPRESSOR SAFETY - Even though compressors are actually powered by electric motors or gasoline engines, they will be covered here because of their direct use with pneumatic tools.

1. Air storage tanks on compressors must be approved by the American Society of Mechanical Engineers (A.S.M.E.) and have this approval permanently stamped into them.
2. Drain the water out of the storage tanks at least daily, to prevent rust through and weak points.
3. Compressed air storage tanks must be equipped with a working safety relief valve to prevent exploding.
4. Keep the relief valve and pressure gauge in good working condition.

Assignment



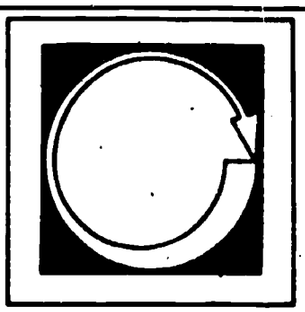
Select any two of the following three assignments to complete instead of taking the Self Assessment and Post Assessment exams.

1. List, step-by-step all of the safety practices that you perform when operating at least two of the electrical, pneumatic, hydraulic, or powder-actuated tools which you use in your work.

2. Write a short report for your instructor, citing at least eight power tool violations at your job site, and explain what can be done to correct the violations.

3. Have your instructor show you or demonstrate to you at least five power tools which are in unsafe condition or unsafe use, and you point out the faults.

Self Assessment



Select the answer which best completes the statement. Write the letter of that answer in the blank to the left of the statement.

1. ____ All electric tools must have:
   a. cover guards
   b. grounding wires
   c. guard covers
   d. receptacles

2. ____ Circular saws should be used to cut:
   a. in the forward motion only
   b. in the backward motion only
   c. in non-ferrous woods
   d. crooked cuts

3. ____ One of the requirements for using compressed air for cleaning is that:
   a. pressure is less than 15 pounds per square foot
   b. pressure is less than 30 pounds per square foot
   c. pressure is less than 15 pounds per square inch
   d. pressure is less than 30 pounds per square inch

4. ____ Regarding pneumatic tool use, hose couplings should be:
   a. fitted with a safety connection
   b. subjected to no more than 15 pounds per square inch
   c. made of 1/2-inch hose
   d. fitted by compressed air

5. ___ When carrying a pneumatic nailer or stapler, always:
   a. point it toward the ceiling
   b. point it toward the floor
   c. point it toward your leg
   d. point it toward a wall

6. ___ If the operator exceeds the air pressure recommended by the manufacturer:
   a. a blowup could occur
   b. ignition could occur
   c. paint droplets will condense
   d. the nozzle could get plugged up

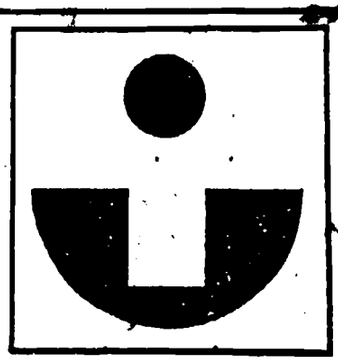
7. ___ Hydraulic fluid must be:
   a. fire resistant
   b. filter resistant
   c. stored in sub-freezing containers
   d. streak-proof

8. ___ Powder-actuated tools should be equipped with a safety device to prevent discharge:
   a. unless the muzzle is pressed against material
   b. at all times
   c. until the tool is dropped
   d. which is a low velocity piston

9. ___ Fasteners should not be driven into:
   a. extremely hard or brittle materials
   b. concrete
   c. wood
   d. particle board

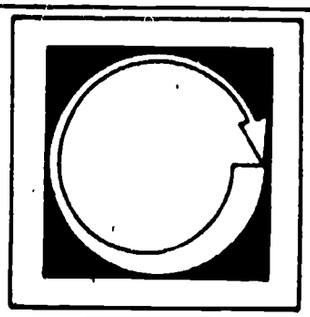
10. ___ Air storage tanks on compressors must be approved by:
   a. American Society of Mechanical Engineers
   b. American Society of Mining Engineers
   c. American Society of Compressor Engineers
   d. American Society of Pressure Engineers

Self Assessment Answers



1. b
2. a
3. d
4. a
5. b
6. a
7. a
8. a
9. a
10. a

Post Assessment



Select the answer which best completes the statement. Write the letter for that answer in the blank at the left of each statement.

1. ____ With which of the following tools would you likely find coolant being used?
   a. circular saw
   b. reciprocating saw
   c. pneumatic stapler
   d. power hack saw

2. ____ Compressed air can be used for cleaning only if the pressure is less than:
   a. 30 pounds per square inch (PSI)
   b. 3 PSI
   c. 60 PSI
   d. 15 PSI

3. ____ When you're finished using a pneumatic tool, you should:
   a. disconnect the air line, then shut the air supply off
   b. shut the air supply off, then disconnect the line
   c. disconnect the air line, then allow it to drain
   d. allow the line to build up pressure until the next job

4. ____ Any pneumatic hose over 1/2" in diameter should have a safety valve that reduces pressure if the hose fails. The safety valve should be located at:
   a. the source
   b. the tip
   c. the coupling
   d. the dryer

5. ____ In operating a portable circular saw, the saw blade should clear the stock by:
   a. 2-3 inches
   b. 1/4 inch
   c. 1/8 inch or less
   d. no more than 1/2 inch

6. ____ A portable circular saw must have a fixed guard over the upper half of the blade and:
   a. a fixed guard over the bottom half of the blade
   b. a portable guard over the bottom half of the blade
   c. a working movable guard over the bottom half of the blade
   d. a flexible guard over the bottom half of the blade

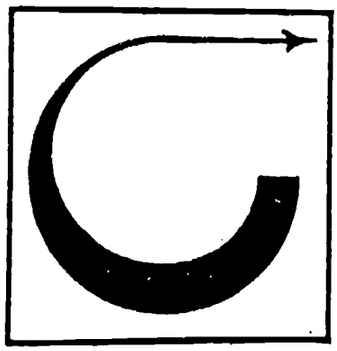
7. ____ Starting the saw and allowing it to come to full speed before cutting will prevent:
   a. overloading
   b. buckling
   c. burrs
   d. blade tension

8. ____ Couplings between hoses must have:
   a. safety valves
   b. safety harnesses
   c. safety connections
   d. safety tensions

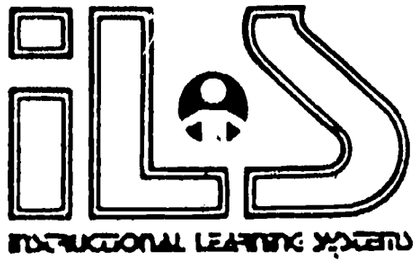
9. ____ Hydraulic fluid must be:
   a. warmed before use
   b. purplish in color
   c. fire resistant
   d. used in powder-actuated tools

10. ____ Fasteners can be driven into:
   a. cast iron
   b. glass block
   c. both of the above
   d. none of the above

Instructor Post Assessment Answers



1. d
2. d
3. b
4. a
5. c
6. c
7. a
8. c
9. c
10. d



2.4

FIRE SAFETY

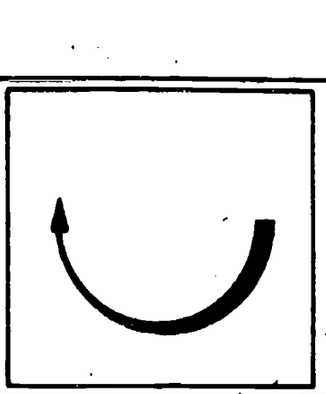
Goal:

The apprentice will be able to describe fire safety practices.

Performance Indicators:

1. Describe fire behavior.
2. Describe the elements of combustion.
3. Describe fire hazards.

Information



Approximately 8,800 people died as a result of fires in the United States during 1976. On account of recent changes in the method of estimation, this total is down sharply from the approximately 12,000 annual fire fatalities estimated by the National Fire Protection Association. The principal reason for this substantial decrease is a major reduction in the number of motor vehicle fire deaths included in the estimate.

Of the 8,800 estimated total United States fire deaths for 1976, approximately 6,200 or 70 percent are estimated to be residential. On account of the revisions in the method of calculating national death statistics, the proportion of fire deaths that are residential has risen substantially from previous estimates and place new emphasis on the relative severity of the residential fire death problem.

FIRE BEHAVIOR SCIENCE

Fire is a chemical reaction known as combustion. It is frequently defined as the rapid oxidation of combustible material accompanied by a release of energy in the form of heat and light.

BASIC COMPONENTS OF BURNING

For many years, the three-sized figure of the fire triangle has adequately been used to explain and describe the combustion and extinguishing theory (Fig. 2-1) Oxygen, heat, and fuel in proper proportions create a fire, and if any one of the three elements is removed, a fire cannot exist. Recently, a new theory has been developed to explain combustion and extinguishment further. Those who developed this theory made a transition from the plain geometric triangular figure, which we recognize as the fire triangle, to a four-sided geometric figure, a tetrahedron (Fig. 2-2), which resembles a pyramid. One of the four sides serves as the base and represents the chemical chain reaction. The three standing sides represent heat, fuel, and oxygen. The removal of one or more of the four sides will make the tetrahedron incomplete and result in estinguishment of the fire.

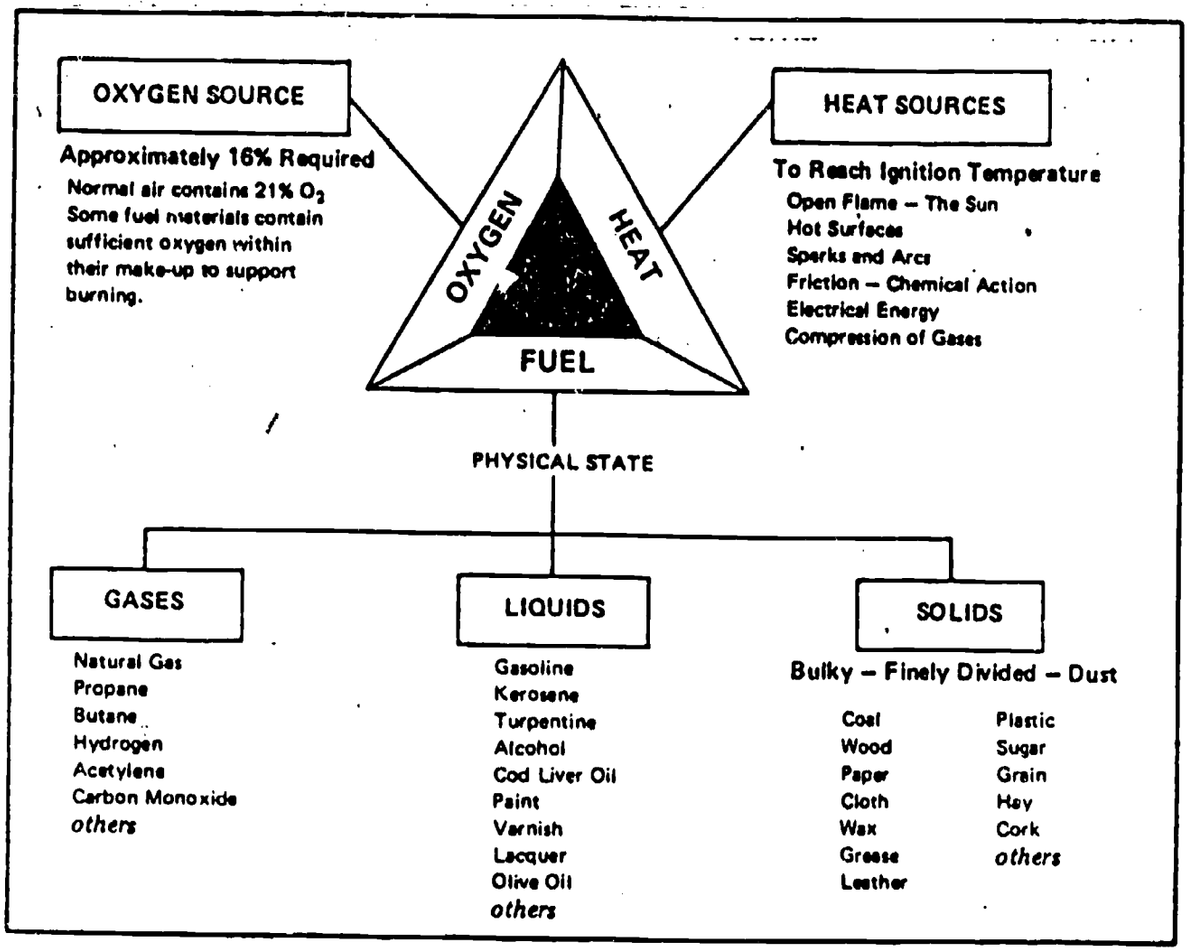


Figure 2-1 The "fire triangle" was used to explain the three components necessary for burning.

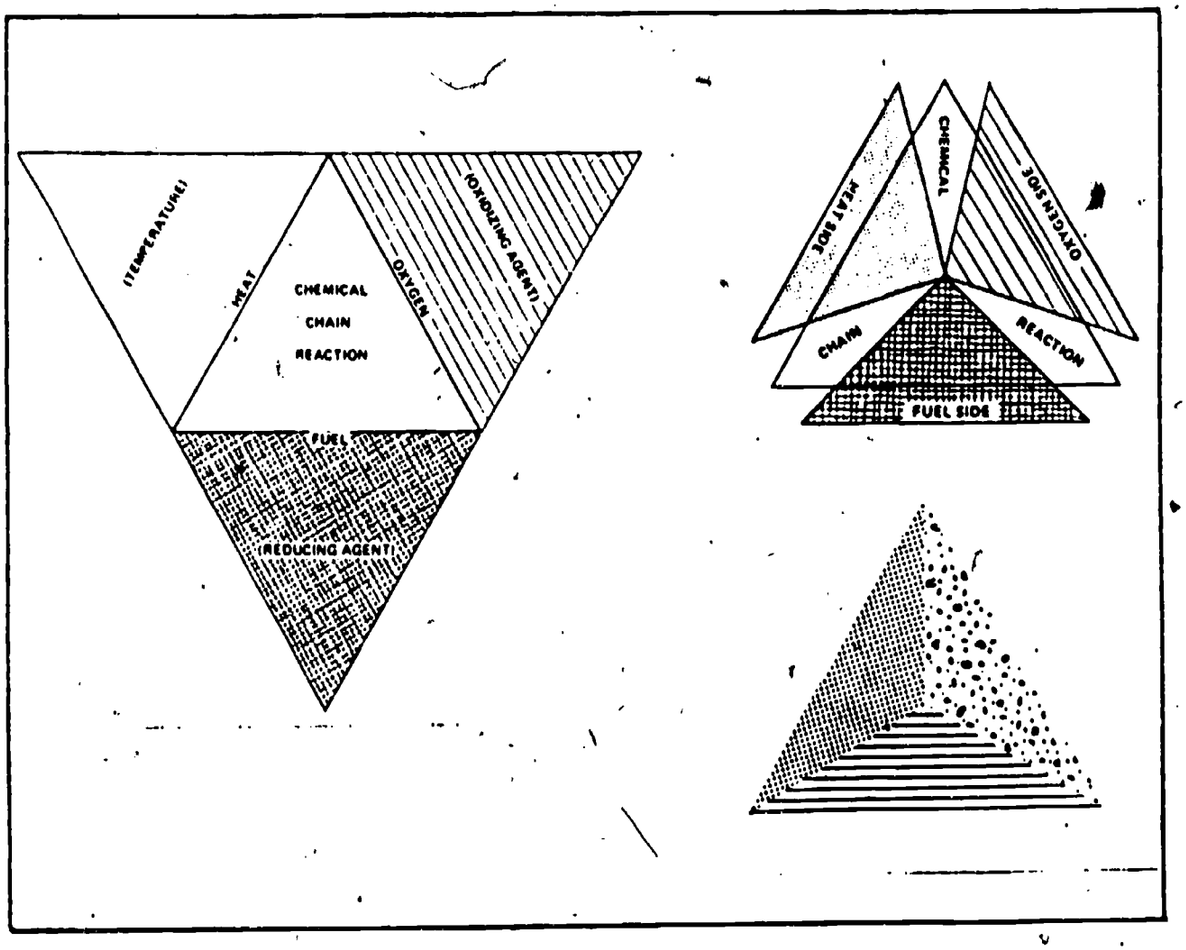


Figure 2-2 The "fire tetrahedron", a four-sided solid, was suggested to include the chemical chain reaction as another component necessary for burning. The components would then form a pyramid.

FUEL

The fuel segment of both the fire triangle and tetrahedron is defined as "any material that can be oxidized." The term "reducing agent" has reference to a fuel's ability to reduce an oxidizing agent.

OXYGEN (Oxidizing Agent)

The term "oxidizing agent" helps explain how some materials, such as sodium nitrate and potassium chlorate, which release their own oxygen under certain conditions, can burn in an oxygen-free atmosphere.

HEAT (Temperature)

Heat and temprature are closely related and in some cases inseparable. Heat is a type of energy in disorder while temperature is a measure of the degree of that disorder.

CHEMICAL CHAIN REACTION

The vapors of gases which are distilled during the burning process of material are carried into the flame. These vapors contain atoms and molecules which have not yet been changed and they have an electrical charge which either attracts or repels other particles (Fig. 2-3).

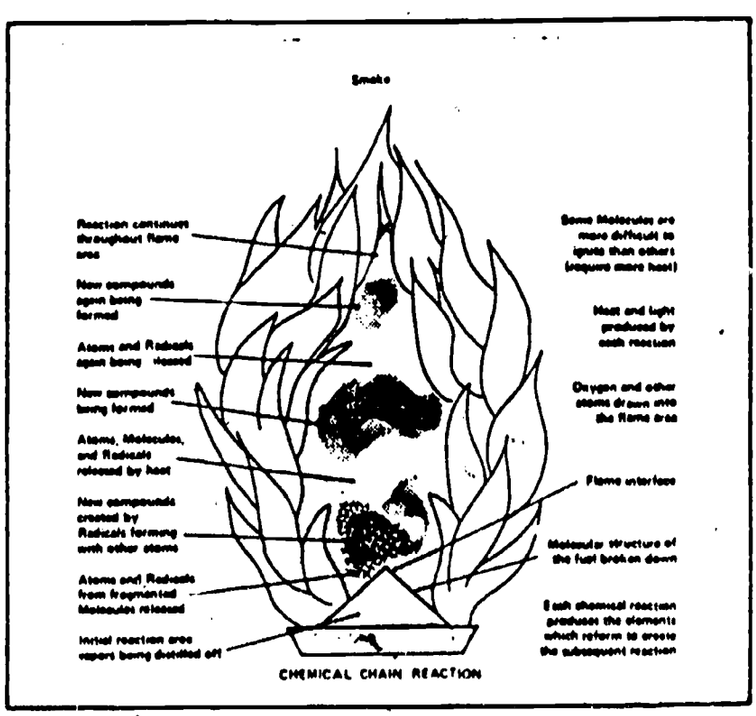


Figure 2-3 Actions during burning which are associated with the chemical chain reaction.

The area between the flame and the fuel is called the "flame interface", a place where very little burning takes place. Oxygen is drawn into the flame area from the interface throughout its uppermost regions. Here the molecular structure of the material is broken down and the released atoms combine with other radicals to form new compounds which are again broken down by the heat. Neither this description nor the reactions depicted in Fig. 2-3 are a step-by-step process, because these reactions occur simultaneously in varying degrees.

PRODUCTS OF COMBUSTION

When a fuel burns it undergoes chemical change and there are four products of combustion: (1) fire gases; (2) flame; (3) heat; and (4) smoke.

FIRE GASES

The term "fire gases" refers to the vaporized products of combustion. The more common combustible materials contain carbon which, when burned, forms carbon dioxide and carbon monoxide. The principal factors which determine the fire gases that are formed by burning are the chemical composition of the fuel, the percent of oxygen present for combustion, and the temperature of the fire. The carbon in most fuels can be burned to complete combustion under controlled conditions. This condition requires the proper mixture of fuel vapors and oxygen being regulated to the extent that most of the gas produced is carbon dioxide. A good example of complete combustion is found with the common fuel methane (a natural gas) and is diagramed as follows and illustrated in Fig. 2-4.

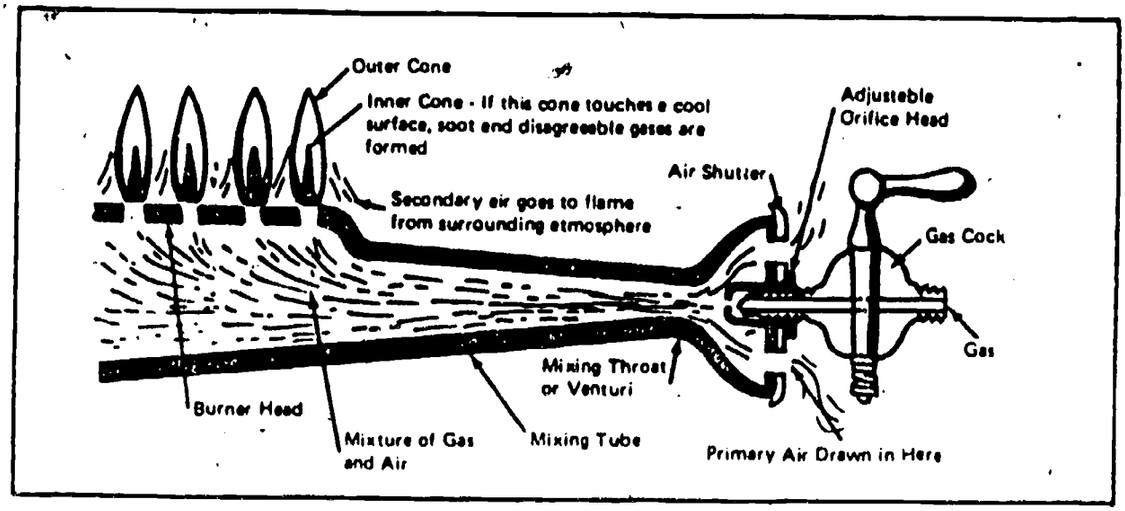


Figure 2-4 Complete combustion of methane occurs when air (O_2) and the fuel are mixed properly.

Under most burning conditions, however, the oxygen concentration is never adequate for complete combustion; consequently, only a part of the carbon is oxidized. This situation is particularly true with carbon fuels other than methane such as wood, cloth, paper, and hydrocarbons. When only a part of the carbon is oxidized, carbon monoxide (C) is formed instead of carbon dioxide (CO_2). While carbon monoxide gas is not the most toxic of fire gases, it ranks first in the cause of fire deaths because it is always one of the most abundant. When two or more gases or vapors are present, their total effect is usually greater than the sum of the factors taken separately. Carbon monoxide (CO) is to unstable and has such an affinity (combining power) for oxygen that it will combine with or rob almost any other oxygen-bearing substance of its oxygen to form CO_2. When carbon monoxide is heated to approximately 1,200 degrees in the presence of oxygen, it will burn to produce carbon dioxide gas. Carbon monoxide gas is colorless, odorless, tasteless, and slightly lighter than air. It may also be produced by sl w oxidation. It may be found in sewers, caves, wells and mines in addition to automobile exhaust smoke, stoves, and furnaces.

Hydrogen sulfide (H_2S) is a fire gas which may be formed during fires involving organic material containing sulfur, such as hair, wool, meat and hides. It is a colorless gas with a strong odor similar to rotten eggs and is highly toxic. It is heavier than air and will ignite when heated to 500 degrees F. Nitrous fumes or oxides of nitrogen are also common fire gases and are very poisonous.

FLAME

Flame is the visible luminous (light) body of a burning gas which becomes hotter and less luminous when it is mixed with increased amounts of oxygen. This loss of luminosity is due to a more complete combustion of the carbon. For this reason, flame is considered to be a product of combustion. However, heat, smoke and gas can develop in certain types of smoldering fires without evidence of flame.

HEAT

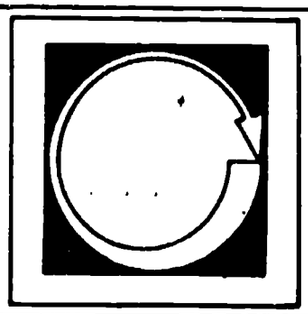
Heat is a form of energy which is measured in degrees of temperature to signify its intensity. In this sense, heat is that product of combustion which is responsible for the spread of fire. In a physiological sense, it is the direct cause of burns and other forms of injury. In addition to burns, heat-related injuries include dehydration, heat exhaustion, and injury to the respiratory tract. Heat, along with oxygen depletion and carbon monoxide formation are

regarded as the primary hazards in fires.

SMOKE

Smoke is a visible product of incomplete combustion. Smoke ordinarily encountered at a fire consists of a mixture of oxygen, nitrogen, carbon dioxide, some carbon monoxide, finely divided particles of soot and carbon, and a miscellaneous assortment of products which have been released from the material involved. In a burning structure, smoke builds up gradually and continuously reduces visability until ventilation is accomplished. Lack of visibility causes disorientation which can trap persons in a smoke-filled building.

Self Assessment



Determine the correct word(s) for each statement and fill in the blanks.

1. The three sides of the fire triangle are _____, _____, and _____.

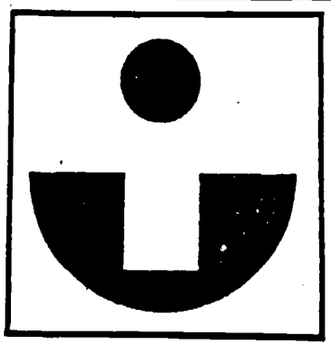
2. More recently a geometric figure known as a fire tetrahedron which forms a pyramid brings into use a fourth component necessary for burning which is _____.

3. Complete combustion produces: _____, _____, _____, and _____ _____.

4. Carbon monoxide is the most toxic of fire gases. True ___ False ___

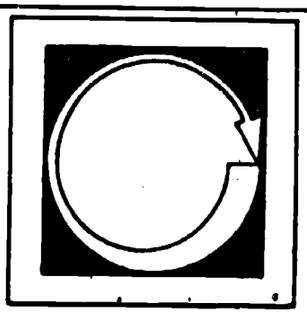
5. Hydrogen sulfide is heavier than air. True ___ False ___

Self Assessment Answers



1. oxygen, heat, fuel
2. chemical chain reaction
3. flame, heat, smoke, five gases
4. True
5. True

Post Assessment



Choose the answer which best fits the question. Write the letter of the answer on the line in front of the question or fill in the blank with your answer.

1. ____ Based on statistics, how many people could you expect to die as a result of fires in the U.S. this year?

   a. 20,000
   b. 10,000 or so
   c. 850
   d. far more than 20,000

2. What are the three ingredients of any fire?

   a. _____
   b. _____
   c. _____

3. ____ Which of the following fuels is an example of a fuel which creates its own oxygen while burning?

   a. wood or textiles
   b. green wood only
   c. tetrahedron
   d. sodium nitrate

4. ____ What are the four products of fuel combustion?

   a. _____
   b. _____
   c. _____
   d. _____

5. ____ Which gas is the most abundantly produced by a fire?

   a. carbon dioxide (CO_2)
   b. carbon monoxide (CO)
   c. hydrogen sulfide (H_2S)
   d. all of them are found in similar quantities

6. ____ Which of the following occurs when oxygen to a fire in increased?

   a. flame becomes hotter
   b. flame becomes cooler but is more visible
   c. more smoke is produced
   d. more hydrogen sulfide is produced

7. ____ Which of the following is a heat-related injury?

a. boils
b. dehydration
c. hardening of the arteries
d. softening of the arteries

8. ____ Statistically, what percentage of deaths due to fire are residential in nature?

a. 77%
b. 88%
c. 82%
d. 70%

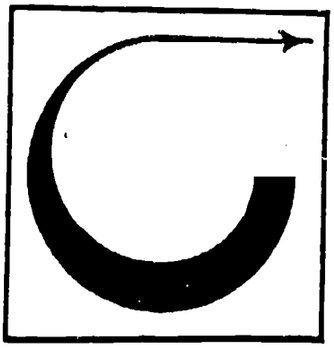
9. ____ The term "fire gases" refers to

a. the vaporized products of combustion
b. the vaporized products of smoke
c. the vaporized products of atom release
d. the vaporized products of oxidizing agents

10. ____ Which of the following is probably <u>not</u> a part of smoke?

a. carbon dioxide
b. titanium crystals
c. oxygen
d. soot

Instructor Post Assessment Answers



1. b
2. a. fuel, b. heat, c. oxygen
3. d
4. a. smoke, b. fire gases, c. heat, d. flame
5. b
6. a
7. b
8. d
9. a
10. b

INSTRUCTIONAL LEARNING SYSTEMS

2.5

HYGIENE SAFETY

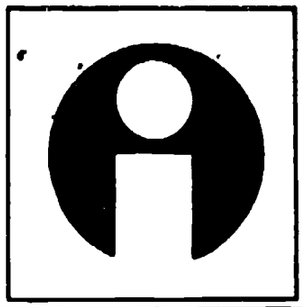
Goal:

The apprentice will be able to describe occupational health hazards and their prevention.

Performance Indicators:

1. Describe noise hazards to human health.
2. Describe dust, vapor and fume hazards.
3. Describe chemical hazards.

Study Guide



For successful completion of this module:

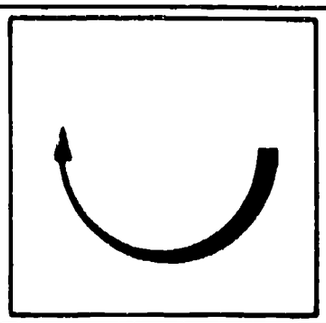
1. Familiarize yourself with the objectives on the cover sheet of this module.

2. Study the Information section.

3. Take the Self Assessment.

4. Take the Post Assessment.

Information



An industrial hygienist is a person who has been trained in recognizing, evaluating, and controlling environmental factors. The hygienists concern themselves with the chemical, physical, biological, or stress factors that may cause illness, impaired health, or significant physical discomfort to employees.

Health hazards frequently result in employee over-exposure to toxic materials. There are many toxic materials, some of which you are probably quite familiar with, such as chlorine gas or carbon monoxide.

When an employee becomes over-exposed to toxic materials, his or her health can be affected either internally (vital internal organs) or externally (skin, sense organs). Therefore health hazards result from both INTERNAL and EXTERNAL exposure to toxic materials.

INTERNAL EXPOSURE results in damage to internal organs from harmful or toxic materials entering the body in three ways.

1. By breathing contaminants into the respiratory tract or lungs, such as dust, fumes, vapors, mists, or gases.
2. By swallowing contaminants with saliva, water, or food into the digestive tract.
3. By absorption through the skin.

Many substances, such as TNT, leaded gasoline and hydrogen cyanide can produce internal poisoning by direct contact with the skin. If there are wounds such as open cuts, scratches, or breaks in the skin, absorption is still easier.

The other type of health hazard, EXTERNAL EXPOSURE, can be defined as a contact with the skin or sense organs by harmful elements, or simply too much contact with an ordinarily harmless element. Effects of external exposure can vary quite widely --from skin rashes to severe burns. Even noise can be considered an external health

hazard.

NOISE

Exposure to noise affects one of our senses; the sense of hearing. There are five senses: sight, hearing, smell, taste, and touch. Any one of these senses can be affected by external over-exposure to toxic materials, or physical agents.

Until three decades ago, the effect of noise hazards on workers was not regarded as significant by some employers. As more information was gathered, it became evident that many employees were suffering from acute hearing losses due to the noise levels in their work area. To effectively combat the problems of excess noise in your work area, you should understand some of the basic concepts of sound and noise levels.

The noise level of any operation is measured in terms of DECIBELS (dB). A decibel is the measurement of the intensity of a sound. Different sounds have different decibel levels. For example, the intensity of a soft whisper is about 30 dB, normal speech is about 73 dB, and a jet airplane gives off an intensity level of about 160 dB. If you have ever been near a jet airplane when the engines were on, you will probably remember how loud and possibly painful the noise was.

One important point to remember, with regard to sound, is that a hearing loss usually occurs only after a worker has been exposed to a noise level over a period of time. For example, we listed the intensity level of a jet airplane as 160 dB. If you were at an airport and were near the airplane for a short time, you wouldn't experience a permanent hearing loss. But if you had to work near airplanes all day, and didn't wear ear protection, you would eventually experience a hearing loss.

Following is a list of exposure levels a worker can tolerate for a certain number of hours per day over a long period of time.

Maximum Hours of Exposure Per Day	Sound Level Measured in dBA
8	90
6	92
4	95
3	97
2	100
1 1/2	102
1	105
1/2	110
1/2 or less	115

As you have probably noticed in the sound exposure levels, the notation dBA is used. We have already explained what decibel (dB) means. The "A" stands for a scale on a sound level meter, which approximates the range of a person's hearing. Whenever a qualified person measures the noice level in your work area, he or she will use a sound meter.

If excessive noise exists, temporary measures, such as ear plugs or ear muffs, should be instituted immediately, while steps for a permanent solution are being taken. Industrial hygienists or safety and health specialists can help to recommend the best course of action.

Not only does noise affect the ability to hear, it also affects the body itself. Noise can cause changes in the size of blood vessels, restricting the flow of blood, making the heart work faster. Noise also affects the brain, causing blood vessels to enlarge and produce headaches. Other body organs, such as the kidneys, also are affected by noise.

Excessive noise affects the rest of your body and therefore can also be an internal exposure.

Noise can also stimulate an individual to a nervous peak. Momentary lapses of efficiency result which lead to errors in judgment. This may be reflected in a reduced quality of work and an increased number of accidents.

There are many permanently harmful consequences for employees who are over-exposed to toxic materials. The following table indicates the results of over-exposure to some specific toxic materials or hazardous physical agents.

Sense Organ	Exposure to:	Effect of Extreme Overexposure
Eyes (Sight)	Butyl Alcohol	Loss of Sight
Ears (Sound)	Excessive Noise Levels	Loss of Hearing
Nose (Smell)	Acetic Anhydride	Loss of Sense of Smell
Mouth (Taste)	Chromium	Loss of Sense of Taste
Skin (Touch)	Phenol	Extreme Dermatitis

External exposure to certain chemicals removes the skin's protective oils and makes it more susceptible to injury. An example of a chemical that will do this is acetone.

There are many ways that materials and chemicals can affect the body. The first specific type we will talk about is called exposure to AIRBORNE CONTAMINANTS. They are measured in Threshold Limit Values (TLV). TLV refers to airborne concentrations of substances, and represents limits under which nearly all employees may be exposed without adverse effects. Threshold limit values are stated in terms of time weighted concentrations for an 8-hour workday and 40-hour workweek.

Following is a brief description of each of the categories of airborne contaminants which can be commonly found at work sites.

DUSTS are airborne particles generated mechanically from operations such as drilling, cutting, blasting, crushing, and grinding. Dust particles are measured in microns (microns are about 1/25,000 of an inch in size). Most dust averages between 1/2 to 3/4 of a micron. Dust particles therefore can not be seen by the human eye. They can affect a person's skin, eyes and lungs.

Another airborne contaminant is FUME. Fumes are solid particles that are produced by condensation of vapor usually accompanied by chemical changes. Examples are welding, burning, and decomposition by heat. The most common fumes are caused by the oxidation of a metal. Fumes are usually smaller than dust and range generally below 1 micron; they cannot be seen by the naked eye either.

Another airborne contaminant is MIST. Mists are particles of liquids or mixtures of liquids and solids. The size of a mist depends upon the process by which it is made. An example is the chromium plating process.

Another airborne contaminant is GAS. Gas is a low density material that can expand and contract when it comes into contact with different ranges of temperature and pressure. A gas can be changed to a liquid or solid by proper changes of both temperature and pressure.

An example of this type of airborne contaminant would be a gasoline engine propelled forklift that puts out carbon monoxide in the form of a poisonous gas. Employees should take extreme care when they operate a gasoline propelled vehicle in a

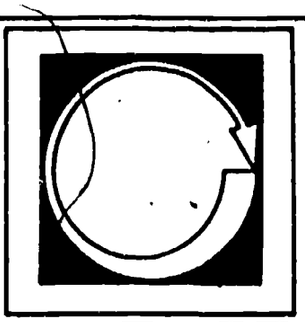
closed space.

The last airborne contaminant we will discuss is called VAPOR. Vapors are gaseous forms that normally are in the solid or liquid state at room temperature. Most vapors can be changed back to a solid or liquid state by increasing the pressure OR decreasing the temperature. This differentiates vapors from gases, since gases change to a solid or liquid by changing both temperature AND pressure.

Most hazardous materials can be classified by the way they affect the body. Airborne contaminants, in addition to those already mentioned, may include the following: 1) IRRITANT materials that attack the lungs, 2) ASPHYXIANT materials that combine with the blood to prevent the normal transfer of oxygen to the tissues, 3) ANESTHETIC and NARCOTIC materials that cause sleepiness and nausea, 4) SYSTEMIC poisons that attack the vital organs of the body such as the liver and kidneys.

Short of covering your entire body and breathing from a self-contained unit, there is virtually no way to protect yourself from the many gases, fumes, etc. which are found at many work sites. Fortunately, the body can accept many of them for short periods with little negative effect. Ventilation is the most effective way to deal with most of them, circulating air which replinishes contaminated air with fresh air. Gloves, proper clothing and face shields may be necessary in some instances. Respirators, or other artificial breathing devices, should be used only as a last resort.

Self Assessment



From the four possible answers below each statement, select the one that correctly completes the statement. Place the letter for that answer in the blank to the left of the statement.

1. ____ How many hours per day could employees work in an area that was measured to be 100 dBA?
   a. one hour
   b. two hours
   c. three hours
   d. four hours

2. ____ If vapor, mist, gas, fumes, or dust in your work area irritates your EYES, the effect would be called an _____ exposure.
   a. internal
   b. illegal
   c. external
   d. isotonic

3. ____ A material that causes a worker to pass out because of lack of oxygen would be:
   a. irritant
   b. asphyxiant
   c. external
   d. systemic

4. ____ What would the effect of dust on an employee be called?
   a. negligible
   b. internal exposure
   c. external exposure
   d. both b and c

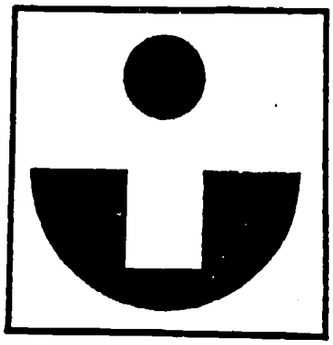
5. ____ Noise may cause:
   a. temporary loss of vision
   b. temporary loss of hearing
   c. both a and b
   d. loss of hearing, stress, loss of concentration

6. ____ Noise has been regarded as a health and safety hazard for:
   a. about 300 years
   b. about 30 years
   c. about 3 years
   d. about 3,000 years

7. ____ Which of the following is clearly an example of internal exposure?
   a. breathing contaminants
   b. swallowing contaminants
   c. absorbing contaminants
   d. all of the above

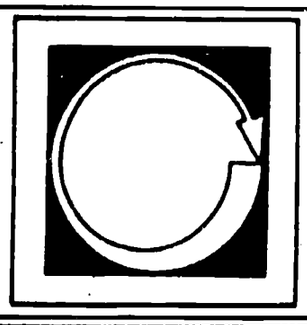
8. ____ An industrial hygienist is a person who can recognize, evaluate, and control:
   a. decibels
   b. chlorine gas
   c. environmental factors
   d. intangible factors

Self Assessment Answers



1. b
2. c
3. b
4. d
5. d
6. b
7. d
8. c

Post Assessment



Select the answer which best completes each statement. Write the letter for that answer in the blank to the left of the statement.

1. ____ Noise can affect:
   a. the ability to hear
   b. the body itself
   c. both of the above
   d. airborne contaminants

2. ____ Which of the following is an example of a vapor?
   a. the smell of soup heating on a stove
   b. a small particle of liquid from the air in a chrome plating factory
   c. a TLV
   d. those small particles in the air after blasting a hillside

3. ____ Which of the following is not an airborne contaminant?
   a. gas
   b. sunlight
   c. dust
   d. fume

4. ____ A material which affects the heart is called:
   a. an irritant
   b. an asphyxiant
   c. a narcotic
   d. a systemic poison

5. ____ The best way to protect yourself from airborne contaminants is:
   a. wear a cotton hood
   b. ventilate the area
   c. wear a pressurized suit
   d. wear gloves and a shield

6. ____ The main difference between dusts and mists is:
   a. one can kill you and the other can't
   b. the size
   c. no difference
   d. one may be a particle comprised of liquids

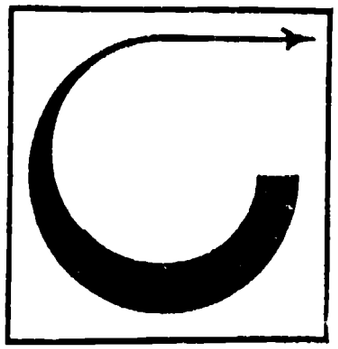
7. ____ Exposure to toxic materials can result in:
   a. internal damage
   b. internal or external damage
   c. internal and external damage
   d. external damage

8. ____ Swallowing contaminated material is an example of:
   a. internal exposure
   b. stomach cramps
   c. external exposure
   d. both internal and external exposure

9. ____ TLV refers to:
   a. thematic limit values
   b. concentrations of substances and the time which the body can withstand them
   c. only airborne particles of dust, mist or vapor
   d. none of the above

10. ____ If your skin absorbs a toxic material like gasoline, you run the risk of:
   a. internal injuries
   b. toxic hydrosis
   c. industrial hygiene
   d. loss of hearing

Instructor Post Assessment Answers



1. c
2. a
3. b
4. d
5. c
6. d
7. c
8. a
9. b
10. a

2.6

SAFETY AND ELECTRICITY

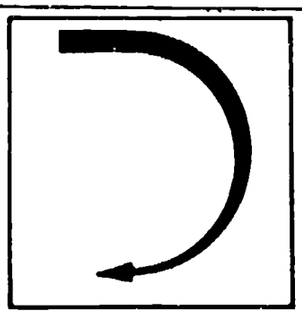
Goal:

The apprentice will be able to describe safety practices in working with electrical circuits.

Performance Indicators:

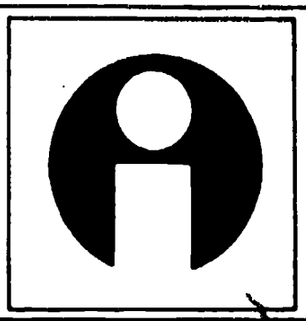
1. Describe circuit protection.
2. Describe grounds.
3. Describe electrical hazards.

Introduction



Without power tools of many kinds, today's skilled worker could not produce work of the quality and quantity currently demanded in technical occupations. Not too many years ago, the only portable electric tool regularly found on the job was the electric drill. Today, portable electric tools of many kinds are available, and the apprentice is expected to learn early in his career how to operate all such tools used in his trade. This module describes some of the most common portable electric tools and gives information needed for their effective and safe use.

Study Guide



To successfully complete this module, complete the following tasks in the order listed. Check each one off as you complete it.

1. ____ Read the Goal and Performance Indicators on the cover of this module. This will inform you of what you are expected to gain from completing this module and how you will demonstrate that knowledge. Read the Introduction section to understand why this module is important.

2. ____ Study the Information section of this module to acquire the knowledge necessary to complete the Self and Post Assessment exams.

3. ____ Complete the Self Assessment exam and compare your answers with those on the Self Assessment Answer Sheet on the page immediately following the exam. Re-study or ask your instructor for help on any questions you have trouble with. The Self Assessment exam will help you determine how well you are likely to do on the Post Assessment.

4. ____ Complete the Post Assessment exam and turn your answers in to your instructor. It is recommended that you score 90% or better on the Post Assessment before going on to the next module.

Information

PORTABLE ELECTRIC DRILLS

The portable electric drill is the most versatile and probably the most often used power hand tool. (See Fig. E-49.) The more powerful tools of this type can be used not only to drill holes but also--with special bits and attachments--to sand, polish, countersink, grind, hammer, stir nonflammable paint, and drive screws. With other attachements, the drill can be converted to a circular saw, a jigsaw or a table saw, but such conversions are more popular with the hobbyist than with the production-minded industrial user; the latter will generally prefer to use a power tool specifically designed for the job at hand.

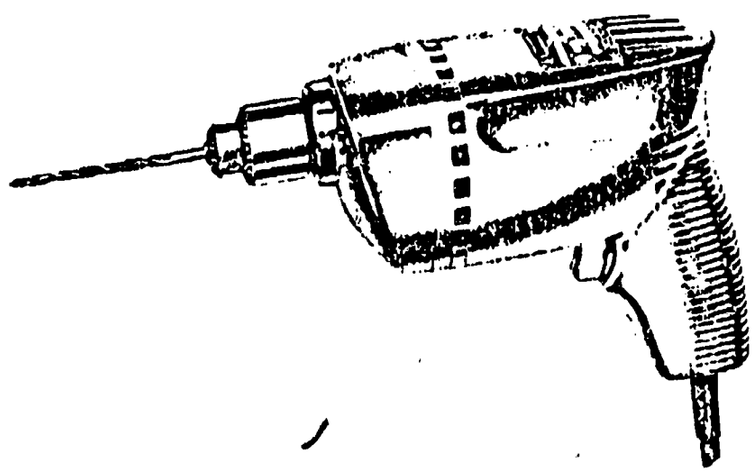


Fig. E-49. Portable electric drill

The 1/4 in. electric drill is generally a high speed tool intended for relatively light-duty applications; the more powerful but lower-speed 3/8 in. and 1/2 in. drills are used for heavier jobs. The chuck speed specified by the power-tool manufacturer is generally the "no-load" or free-running speed. The drill speed will slow down considerably during the drilling operation. If the job calls for heavy work, an electric drill must be selected that has enough power to turn the chuck at the desired speed without overloading (and thus overheating) the motor.

A cordless drill that requires no power connection is available; its power source is a self-contained, rechargeable battery. Unlike other portable electric tools, the cordless drill need not be grounded for safety. This power tool has obvious advantages for working on roofs, in wet locations, or in other places where it is difficult or dangerous to run the cords of conventional electric drills.

PORTABLE ELECTRIC SAWS

Hand-operated saws still have many uses in the skilled trades; however, portable electric saws, because of their versatility and high production capability, have become the preferred types, particularly in the construction industry. The most widely used portable electric saws are probably the electric handsaw and the sabre saw.

THE ELECTRIC HANDSAW

Electric handsaws (portable electric circular saws) are made in sizes to accomodate saw blades ranging in diameter from about 6 in. to about 9 in. The greater the blade diameter, the greater the maximum depth of cut of the saw. A saw with a 6 1/2 in. blade will make a cut about 2-3/32 in. deep; a 7-1/4 in. saw, a cut about 2-7/16 in. deep. (See Fig. E-50.)

FEATURES OF ELECTRIC HANDSAWS. Electric handsaws are used primarily for cross-cutting and ripping wood, standard models being equipped with a combination wood-cutting blade. Special types of blades are available for cutting nonferrous metals and ceramics. The base of the saw may be raised or lowered to control the depth of the cut, and most saws will make a bevel cut up to 45^{0}. The blade rotates counter-clockwise and cuts in the upward direction. The upper half of the blade is shielded by a fixed guard; the lower half is shielded by a hinged or telescoping guard that opens as the blade is presented to the work and automatically closes over the blade when the cut is completed.

SAFETY AND THE ELECTRIC HANDSAW.

If improperly used, the electric handsaw can be the most dangerous of all portable electric tools. General instructions for the grounding and safe operation of all portable electric tools, including saws, are given elsewhere in this topic; however, every mechanic should also observe the following special safety rules whenever the need arises for using an electric handsaw:

- Before connecting the saw to the power source, be sure the saw blade is tight on

the arbor, all guards are in place and in good working order, and all adjusting devices for depth and angle of cut are securely tightened at the desired settings. Never make adjustments to the saw without first disconnecting the power cord from the outlet.

- Inspect the work before beginning the cut to avoid cutting into nails or other dangerous obstructions.
- Never reach underneath the material being cut.
- Stand to one side of the cut.
- As soon as the cut is completed, release the switch. Wait until the blade stops turning before setting the saw down.

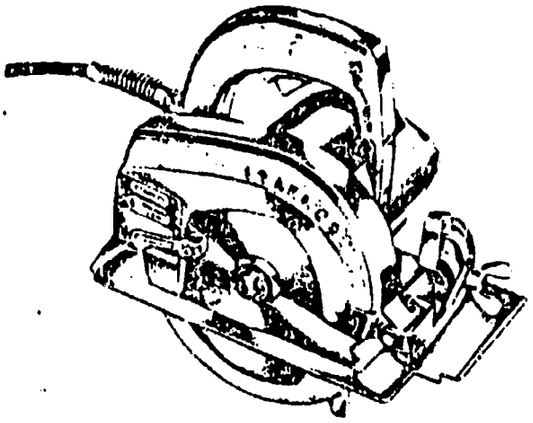


Fig. E-50. Electric handsaw

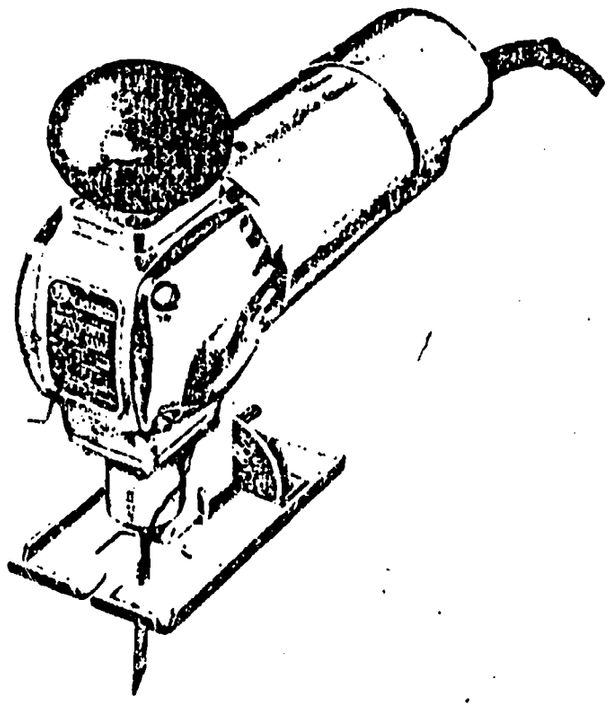


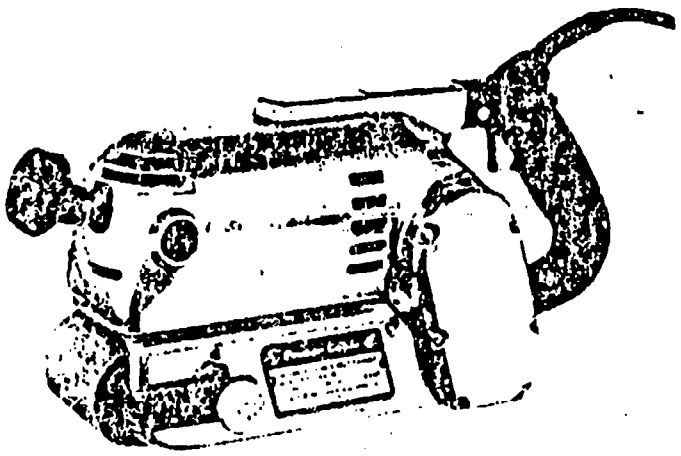
Fig. E-51. Sabre saw

THE SABRE SAW

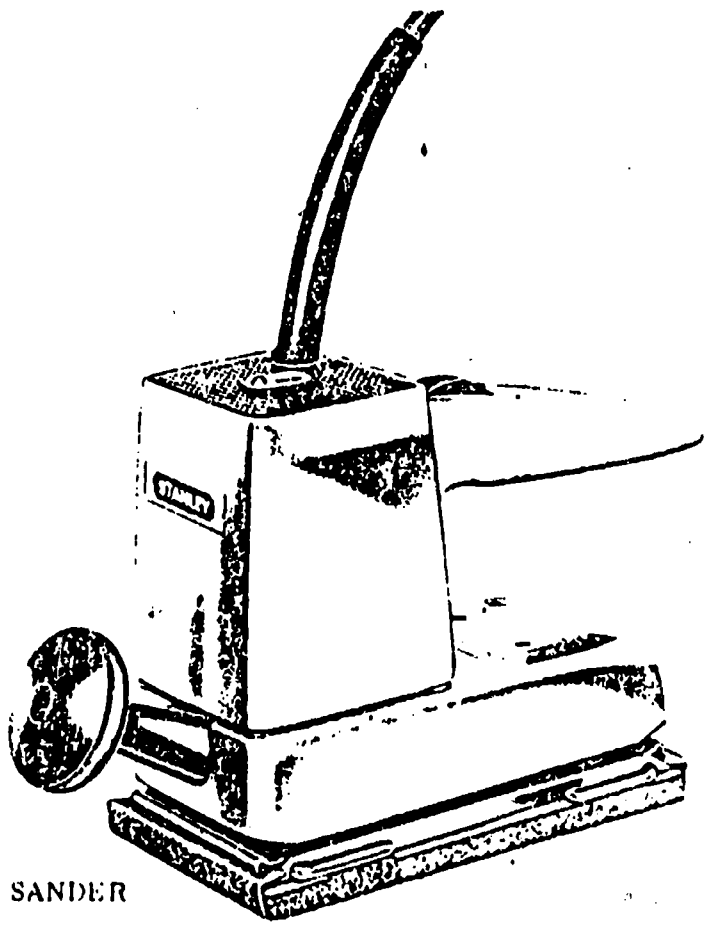
The sabre saw is a reciprocating-blade saw; its blade moves up and down in cutting. (See Fig. E-51.) The blade has a stroke of about 1 in., and its tip is pointed and sharp so that it can start its own hold. Right- or left-hand bevel cuts, sharp angles and curved cuts are practicable with this power tool. Special saw blades are available for cutting materials other than wood. The average cutting speed of sabre saws is about 3,800 strokes per minute.

PORTABLE ELECTRIC SANDERS

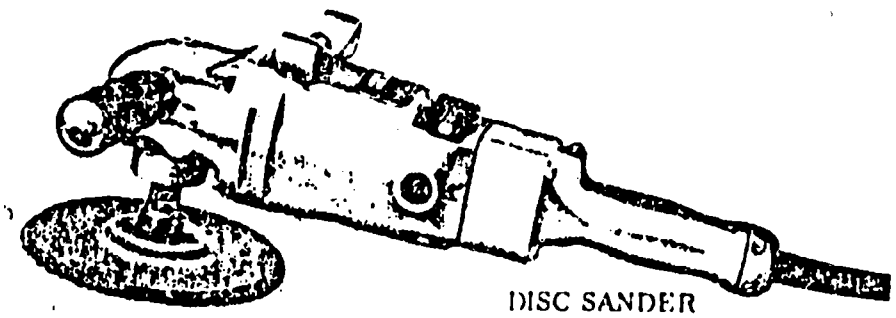
Three types of portable electric sanders are in wide use: the belt sander, the orbital sander and the disc sander. (See Fig. E-52.) These power tools range in weight from about 6 pounds to about 30 pounds; the weight of the tool can therefore be a consideration if the worker must support it for a long period in an awkward position. Some types of power sanders are equipped with a bag for collecting the dust produced during operation. This can be a desirable feature, especially if the sander is to be used for prolonged periods; it is unpleasant and even unhealthful to breath the dust resulting from the sanding operation.



BELT SANDER



ORBITAL OR FINISHING SANDER



DISC SANDER

Fig. E-52. Portable electric sanders

THE BELT SANDER

The belt sander is most useful for sanding large, flat areas. The sanding is done in a straight line by a continuous belt that runs over a base plate at high speed. When used on wood, the sander should be directed with the grain. Belts are available in several abrasive grades for rough to fine sanding of wood, and special belts are available for materials other than wood. Belt sanders are sized by the width and length of the belt.

THE ORBITAL SANDER

The orbital or finishing sander has a rectangular, padded base plate to which a piece of abrasive paper or cloth is attached by means of clamps. The rotary motor of the tool is geared to move the base plate rapidly in a limited circular orbit, and the plate oscillates--moves back and forth and from side to side--thousands of times per minute as its sands. The orbital sander can therefore be operated either with or against the grain, and it can be used in small spaces and corners. It is most useful for finish work.

THE DISC SANDER

The flexibility of its rotary sanding disc makes the portable electric disc sander better suited for sanding uneven or curved surfaces than a straight-line sander. The disc is removable and can be replaced with attachments for wire brushing, polishing, buffing and even drilling.

GROUNDING PORTABLE ELECTRIC TOOLS

Safety requires that portable electric tools must be grounded when in use unless they are of the cordless (battery-operated) type. An electrical system or appliance is grounded when those metal parts of it that are not intended to carry current--the frame and the housing, for instance--are connected to the earth through some conductive material, normally a grounding wire. The purpose of the grounding conductor is to carry electric current harmlessly away if it should "leak" to the metal case of the appliance or tool. Such leaks, which are called fault currents, result from breakdown of the insulation of the conductors within the tool. When a live, uninsulated conductor "shorts" to the frame or case of a power tool that is not properly grounded, the exposed metal parts of the tool also become live. The tool thus presents a serious shock hazard to the user, who risks being badly burned or even killed as a result of a heavy fault current flowing from the defective tool through his or her body to the earth. A correctly grounded power

tool gives the user his or her best protection against the hazard of severe or even fatal electric shock.

The shorting of live conductors with defective insulation to frames, housing and other normally neutral metal parts can occur in any electrical system or device, but this defect is most likely to occur in portable equipment, which is often subjected to hard use under adverse conditions. The felxible power cords of portable electric tools are particularly vulnerable to damage. Misuse or abuse of a power tool or its cord can also add to the probability of early electrical failure and resulting shock hazard.

THE GROUNDING CONNECTION

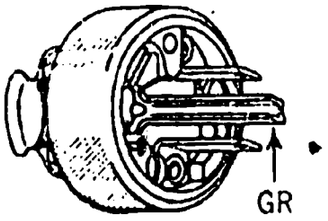
To be effective, the grounding connection must be continuous from the housing or frame of the tool through the tool's power cord and plug to the outlet box, and thence through the wiring system to a metal pole or water pipe buried in the earth. In other words, whenever a connection is made between any of the component parts of a grounded electrical system--say an electric drill and an extension cord or the extension cord and the service outlet--the grounding wire of each unit in the system must be connected to the grounding wire of the next unit.

GROUNDING CAPS

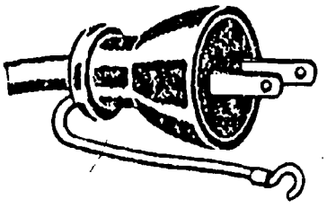
Every new portable electric tool is equipped with a power cord having an extra conductor that serves as a grounding wire, and the cord is terminated with a three-prong grounding cap or plug. The two shorter blades of the cap carry the current. The longer blade serves as the grounding contact; it is connected to the grounding conductor in the power cord. The grounding blade is made longer than the current-carrying blades so that it will be the first to make contact when the cap is being plugged into the receptacle and the last to break contact when the cap is being withdrawn. (See Fig. E-53.)

Many residences and workshops are not equipped with outlets designed for three-prong grounding caps; instead, they have the familiar two-slot receptacles. Adapters are available to permit use of the three-prong grounding cap in a two-slot outlet. Older power tools commonly were equipped with a two-prong adapter cap with a "pigtail" grounding wire like the one illustrated in Fig. E-53. The user is expected to fasten the pigtail connector to the screw in the center of the plate covering the outlet box, but this requirement is often neglected. Even if

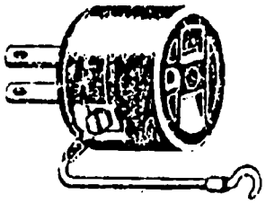
the user remembers to fasten the pigtail to the plate screw, there is no assurance that the appliance will be correctly grounded unless it is known that the house wiring system is correctly grounded. In addition, this old-fashioned adapter cap introduces a new hazard: if the loose pigtail gets caught between the cap and the receptacle and touches the "live" blade of the cap, the entire housing of the tool will then be live and can then give anyone who touches it a severe or even lethal shock. This type of cap is now banned by National Electrical Code and should be replaced by an approved three-prong grounding cap.



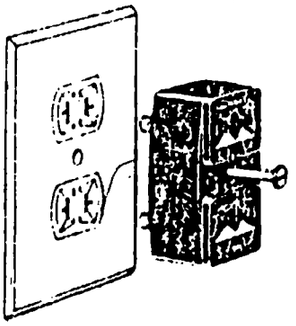
THREE-PRONG GROUNDING CAP. THE LONG BLADE (GR) GROUNDS THE FRAME OF THE TOOL.



ADAPTER GROUNDING CAP WITH PIGTAIL WIRE: SHOULD BE REPLACED WITH THREE-PRONG CAP.



ADAPTER PLUG WITH PIGTAIL WIRE: NOT CONSIDERED A SAFE SUBSTITUTE FOR A THREE-PRONG GROUNDING PLUG.



SCREW-ON ADAPTER: SAFE IF THE ELECTRICAL SYSTEM IS GROUNDED.

Fig. E-53. Grounding caps and adapters

Another type of grounding adapter, the adapter plug with pigtail shown in Fig. E-53, is somewhat safer than the adapter grounding cap because it can be properly attached to the outlet before the power tool is plugged in. However, the same objections can be made to it: it will not ground the appliance if the house wiring system is not correctly grounded and the pigtail might make accidental contact with a live prong.

Still another grounding adapter has a long center screw that replaces the plate screw in the outlet. (See Fig. E-53.) This adapter should provide a safe ground connection if the house wiring system is correctly grounded. If the wiring system

is known or suspected to be ungrounded, a separate wire must be run from the grounding terminal on the adapter to a water pipe.

The use of a grounding adapter of any kind can only be justified on the basis of convenience. For safety's sake, correctly grounded receptacles designed for three-prong grounding caps should be installed in place of the old two-slot receptacles by a competent electrician, who should also be called upon to install three-prong caps on power tools that do not have them. The grounding prong should never under any circumstances be cut off a three-prong cap for the convenience of the moment.

EXTENSION CORDS

Extension cords used with portable electric tools must include a grounding conductor and grounding-type caps and connectors. All conductors must be of adequately heavy gage wire. The required wire gage depends upon the length of the extension cord and the current demand of the power tools with which it is to be used; the greater the cord length and current demand, the heavier the conductor. Extension cords should never be used at voltages beyond their specified maximum. Cords should have molded-on caps and connectors of the "unbreakable" type to preclude any possibility of mistakes in their wiring. Only a competent electrican should be permitted to make up an extension cord on the job or repair existing cords or connectors; if a wire were to be improperly connected in an extension cord, a very dangerous shock hazard could result.

PREVENTING ELECTRICAL OVERLOADS

Correct receptacles and plugs, correctly installed, serve not only to ground electrical equipment but also to prevent equipment rated for one voltage from being connected to a circuit of a different voltage. To ensure against damage to equipment resulting from incorrect line voltage, the current-carrying blades of caps on power cords of equipment rated for 125-volt service are so designed that they cannot be plugged into the slots of 250-volt receptacles, connector bodies or motor bases. (See Fig. E-54.) Also, cord caps for equipment drawing 20 amperes will not fit the slot of grounding receptacles rated for 15-ampere service, and so on.

Old-style T-slot receptacles that accept caps with either parallel or tandem blades may still be encountered in some locations. (See Fig. E-55.) These are now out-

lawed and should be replaced by modern receptacles that have grounding terminals and are keyed to prevent equipment from being plugged into the wrong circuit.

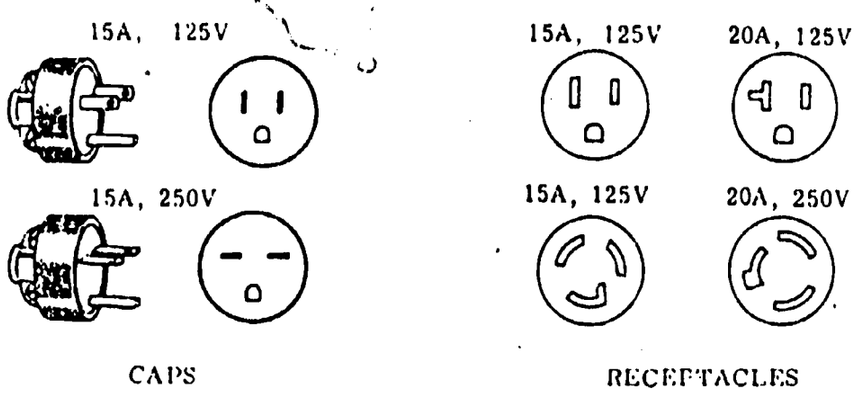


Fig. E-54. Some cap and receptacle types

Fig. E-55. T-slot receptacle (now outlawed)

SAFETY WITH PORTABLE ELECTRIC TOOLS

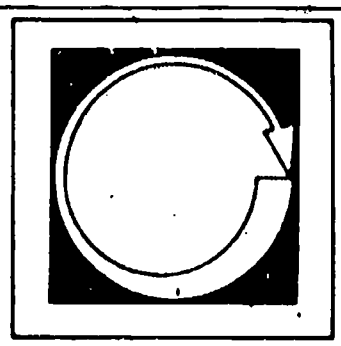
Portable electric tools can be dangerous in the hands of operators who are careless or inadequately trained in their use. Every apprentice should faithfully observe the following safety rules when operating such tools:

- Keep your mind on your work; avoid distractions.
- Be sure that line-powered tools are grounded.
- Keep a firm grip on the tool to retain control if it should catch in the work.
- Be especially careful in wet locations, and never use electric tools where flammable gases or vapors are present. Never use an electric drill to stir paint containing flammable solvents or thinners.
- When you are not using the tool, disconnect it from the power supply.
- Handle power tools with care; sharp blades, bits and other moving parts revolving at great speed can inflict serious injury.
- Arrange power cords so that they will not become fouled in the working parts of the tool. Keep cords away from oil, chemicals and hot surfaces, and never hang them over nails or sharp-edged objects. Never leave cords lying where they might be run over or otherwise damaged or where they could present a stumbling hazard. Store power tools in a clean, dry place with the cords loosely coiled

to protect the cord insulation.

- Never wear loose clothing when operating a portable electric tool or any other power machine.
- Wear safety goggles whenever the use of the power tool could result in the slightest danger to the eyes.

Self Assessment



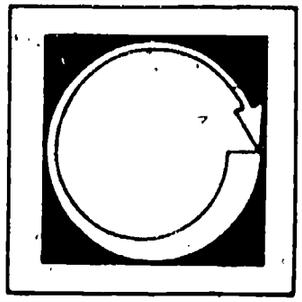
Read each statement and decide whether it is true or false. Write T if the statement is true; write F if the statement is false.

1. ____ Portable electric drills are sized by the diameter of the largest drill that will fit the chuck.
2. ____ The rates speed of a portable electric drill is the speed in revolutions per minute when drilling metal.
3. ____ The cordless electric drill offers a safety advantage for work in very wet locations.
4. ____ A portable circular saw can be used with a special blade to cut non-ferrous metals.
5. ____ A portable circular saw cannot be used for making bevel cuts.
6. ____ A receiprocating saw blade is one that moves up and down.
7. ____ The sabre saw is designed for cutting wood only.
8. ____ A belt sander can be used only for rough sanding.
9. ____ A belt sander is a straight-line sander.
10. ____ The disc of a disc sander oscillates at high speed.
11. ____ A portable electric drill with a self-contained power source need not be grounded.
12. ____ The parts of a portable electric tool that must be grounded are those metallic components that are not intended to carry current.
13. ____ The correct power cord for use with a grounding cap is one having an extra conductor in addition to the current-carrying conductors.
14. ____ A grounding adapter is an adequate permanent substitute for a wired-in grounding receptacle.

SELF ASSESSMENT ANSWER SHEET

1. T
2. F
3. T
4. T
5. F
6. T
7. F
8. F
9. T
10. F
11. T
12. T
13. T
14. F

Post Assessment



Listed below each numbered item are four possible answers or completing phrases. Decide which of the four is correct, or most nearly correct; then write the corresponding letter in the blank at the right of that item.

1. ____ The size of a portable electric drill is determined by the tools':
   a. horsepower
   b. voltage rating
   c. chuck capacity
   d. weight

2. ____ The maximum depth of cut of a portable electric circular saw is determined by the:
   a. blade diameter
   b. direction of blade rotation
   c. motor size
   d. type of wood to be cut

3. ____ The portable electric tool best suited for cutting a large hole in a sheet of plywood is a(n):
   a. circular saw
   b. sabre saw
   c. rotary-blade saw
   d. electric drill

4. ____ An electrical tool is grounded if:
   a. it is connected to a receptacle supplying the correct voltage for the tool
   b. its noncurrent-carrying metal parts are electrically connected to the earth
   c. the nameplate of the tool includes the phrase "factory grounded appliance".
   d. the blades of the plug are parallel

5. ____ If a portable electric tool with a three-prong grounding cap must be connected to an old-style two-slot receptacle, the worker should:
   a. cut off the grounding pin
   b. install a new receptacle
   c. install a new cap
   d. use a correctly grounded adapter

6. ____ The portable electric sander best suited for sanding curved surfaces is a(n):

a. orbital sander
b. belt sander
c. disc sander
d. straight-line sander

7. ____ An ungrounded portable electric tool is dangerous to use unless it is:

a. the cordless type
b. used only in dry work areas
c. used only where no flammable gases are present
d. designed for 230-volt operation

8. ____ A 1/4 in. portable electric drill normally takes twist drills of what diameter?

a. 1/4 in. only
b. up to 1/4 in.
c. 1/8 in. to 1/4 in.
d. 1/4 in. to 3/8 in.

9. ____ The manufacturer's specified chuck speed for an electric drill is generally the:

a. no-load speed
b. half-load speed
c. normal-load speed
d. full-load speed

10. ____ Which one of the following must be done before any parts replacements or adjustments are attempted on a portable electric tool?

a. The tool must be cleaned.
b. The power cord must be unplugged.
c. The foreman must be notified.
d. The switch on the tool must be off.