

# Shop Safety



## OBJECTIVES

Upon completion of this chapter, you should be able to:

- ✓ Use shop tools and equipment safely.
- ✓ Understand safety rules.

## KEY TERMS

Class A fire  
Class B fire  
Class C fire  
Class D fire  
flash point

backfire  
popback  
greasesweep  
Hazard Communication  
Standards

MSDS  
dermatitis  
barrier creams  
HEPA vacuum  
electrolyte

## INTRODUCTION

The number one priority of any business is the health and safety of its employees. Shop safety issues are covered here such as:

- A safety test is included at the end of the chapter.
- As you read this chapter, realize that the situations described can and do occur, sometimes often.
- Case histories presented throughout the book are true. Pay extra attention to the safety precautions described.
- Safety precautions are presented for each piece of equipment described in this book.

The employer is responsible for safety training for each employee and for providing a safe working environment. According to federal law, each shop will have a safety training program. A shop owner in Los Angeles was prosecuted in the death of an employee for not providing proper safety training.

The employee is the one who is actually responsible for his or her own safety and the safety of others. Accidents that occur in an automotive shop often happen because safety considerations are not as obvious when repairing automobiles as they are in such trades as roofing or carpentry. Accidents are often caused by carelessness resulting from a lack of experience or knowledge or from being in a hurry and taking short cuts.

Injury accidents are often caused by someone other than the person injured. The person who caused the accident often suffers from guilt from the harm he or she has caused another. In the event of an accident, be sure to inform your instructor or supervisor, who knows what procedures to follow.

Injured persons often suffer from *shock* and should not be left unattended. When an injury does not appear to be serious enough to call an ambulance, a companion should go with the injured party to seek professional help.

The American Red Cross offers thorough first-aid training. Every shop should have someone trained to handle emergencies.

## GENERAL PERSONAL SAFETY

A first-aid kit (**Figure 3.1**) contains items for treating some of the small cuts and abrasions that often happen. Fires and accidents involving lifts and battery chargers happen occasionally in automotive shops. But the most common injuries are mostly preventable injuries involving the *back* or *eyes*.

Gloves, goggles, and respirators are called personal protective equipment, or PPE (**Figure 3.2**).

Wearing eye protection will prevent most eye injuries, so when using machinery eye protection is mandatory. Several types of eye protection are shown in **Figure 3.3**.



Figure 3.1 A first-aid kit.



Figure 3.2 Personal protective equipment includes gloves, a respirator, and ear protection. (Courtesy of Tim Gilles)

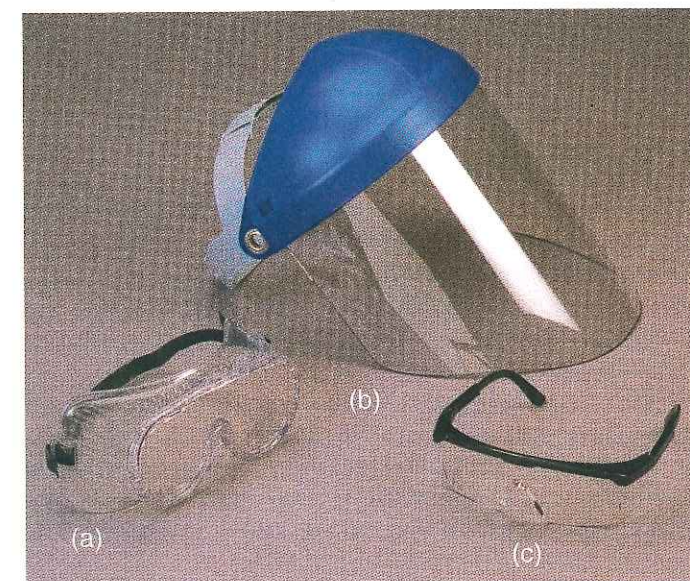


Figure 3.3 Eye protection. (a) Goggles. (b) Face shield. (c) Safety glasses.

**Eye Protection Safety**

Parts can explode when they are pressed or pounded on. Rotating tools can throw pieces of metal or grit, causing eye injuries. Safety goggles or a face shield should be worn when using shop tools and equipment. Because eye injuries are so common in an automotive shop, continual use of safety glasses or goggles is recommended. Prescription safety glasses are an advantage because the user always wears them. Eye protection is emphasized for your protection!

Face shields (see Figure 3.3b) are convenient because they can stay with the piece of equipment. They are also easily adjusted to fit your head.

The following list gives some hints for preventing eye injuries. Eye protection must be worn:

- Whenever working around moving parts and machinery (grinding, cutting, drilling, washing, etc.)
- When blowing off parts with compressed air
- When working under the vehicle
- When working on air conditioning
- When flame-cutting or welding

If your eye is accidentally contaminated with a dangerous liquid, flush thoroughly in an eyewash fountain (Figure 3.4) or other water source.

**Back Protection Safety**

Following safe lifting procedures will prevent most back injuries (Figure 3.5). The following are safety precautions to be used when lifting:



Figure 3.4 An eyewash fountain. (Courtesy of Western Emergency Equipment)

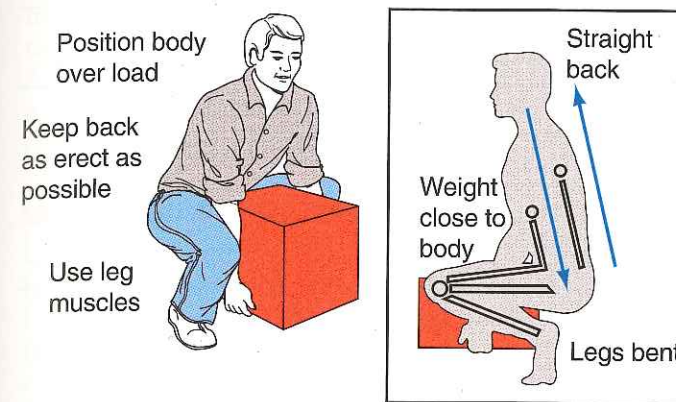


Figure 3.5 Lifting precautions.

- Be sure to get help when moving heavy items. The normal tendency is to say that items are not that heavy and you hate to ask somebody for help. If something is in an awkward position for lifting, leverage and the position your back is in can make it easier for an injury to occur.
- If an item is too heavy to lift, use the appropriate equipment.
- Before moving a heavy item, plan the route that the item will be carried and how it is to be set back down when you get there.
- Lift slowly.
- Do not jerk or twist your back. Shift your feet instead.
- Bend your knees and lift with your legs, not your back! Also, keep your lower back straight when lifting. Think about thrusting your stomach out.

**CASE HISTORY**

A technician lifted a spare tire out of the trunk of a car. As he reached forward and tugged the tire up and out of the trunk, he felt a small pop in his lower back. The result was a herniated disk in his lower back, an injury that will affect him for the rest of his life.

**Ear Protection**

Damage to ears happens due to exposure to loud noises over a period of time. When loud air tools are used, ear protection should be worn.

**NOTE:** Once it has been damaged, your hearing will not recover.

**Clothing and Hair**

Clothing (shirt tails) or hair that hangs out can get caught in moving machinery or under a creeper. Keep long hair tied or under a cap. Shirt tails should be tucked in, or shop clothing can be worn over the shirt.

**Shoes or Boots**

Leather shoes or boots offer much better protection than tennis shoes or sandals. Soles are available that resist slipping and are resistant to damage from petroleum products. Boots and shoes that have the toe reinforced with steel inserts are widely available.

**Hand Protection**

Cuts and scrapes are common when repairing automobiles. Be sure to keep your fingers away from moving machinery and hot surfaces.

Solvents used to clean parts can damage skin. Some types of solvents can actually penetrate your skin. Use the correct type of glove when handling chemicals (see Figure 3.2). Some inexpensive gloves will actually allow some chemicals to pass through them. The use of gloves is becoming more common in the automotive repair industry.

**FIRE SAFETY**

Two major items should be considered when dealing with fires. A little common sense is important. If the fire is burning so dangerously that your personal safety is jeopardized, leave the area immediately and call for help. If you can safely remove the source of fuel or heat to a fire, do so. This might include shutting off fuel to a fuel fire or disconnecting the electrical source from an electrical fire.

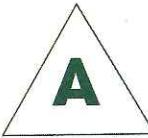
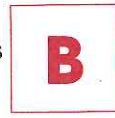


**FIRE EXTINGUISHERS**

A fire extinguisher is a portable tank that contains water or foam, a chemical, or a gas (Figure 3.6). There are four kinds of fires, each calling for a different type of fire extinguisher (Figure 3.7):

- A **Class A fire** is one that can be put out with water. Such items as paper and wood make up these kinds of fires.



Figure 3.6 Fire extinguishers.

	Class of Fire	Typical Fuel Involved	Type of Extinguisher
Class  Fires (green)	<b>For Ordinary Combustibles</b> Put out a Class A fire by lowering its temperature or by coating the burning combustibles.	Wood Paper Cloth Rubber Plastics Rubbish Upholstery	Water* <sup>1</sup> Foam* Multipurpose dry chemical <sup>4</sup>
Class  Fires (red)	<b>For Flammable Liquids</b> Put out a Class B fire by smothering it. Use an extinguisher that gives a blanketing flame-interrupting effect; cover whole flaming liquid surface.	Gasoline Oil Grease Paint Lighter fluid	Foam* Carbon dioxide <sup>5</sup> Halogenated agent <sup>6</sup> Standard dry chemical <sup>2</sup> Purple K dry chemical <sup>3</sup> Multipurpose dry chemical <sup>4</sup>
Class  Fires (blue)	<b>For Electrical Equipment</b> Put out a Class C fire by shutting off power as quickly as possible and by always using a nonconducting extinguishing agent to prevent electric shock.	Motors Appliances Wiring Fuse boxes Switchboards	Carbon dioxide <sup>5</sup> Halogenated agent <sup>6</sup> Standard dry chemical <sup>2</sup> Purple K dry chemical <sup>3</sup> Multipurpose dry chemical <sup>4</sup>
Class  Fires (yellow)	<b>For Combustible Metals</b> Put out a Class D fire of metal chips, turnings, or shaving by smothering or coating with a specially designed extinguishing agent.	Aluminum Magnesium Potassium Sodium Titanium Zirconium	Dry powder extinguishers and agents only

\*Cartridge-operated water, foam, and soda-acid types of extinguishers are no longer manufactured. These extinguishers should be removed from service when they become due for their next hydrostatic pressure test.

- Notes:
- (1) Freeze in low temperatures unless treated with antifreeze solution, usually weighs over 20 pounds, and is heavier than any other extinguisher mentioned.
  - (2) Also called ordinary or regular dry chemical. (solution bicarbonate)
  - (3) Has the greatest initial fire-stopping power of the extinguishers mentioned for class B fires. Be sure to clean residue immediately after using the extinguisher so sprayed surfaces will not be damaged. (potassium bicarbonate)
  - (4) The only extinguishers that fight A, B, and C class fires. However, they should not be used on fires in liquified fat or oil of appreciable depth. Be sure to clean residue immediately after using the extinguisher so sprayed surfaces will not be damaged. (ammonium phosphates)
  - (5) Use with caution in unventilated, confined spaces.
  - (6) May cause injury to the operator if the extinguishing agent (a gas) or the gases produced when the agent is applied to a fire is inhaled.

Figure 3.7 Guide to Fire Extinguisher Selection.

- A **Class B fire** is one in which there are *flammable liquids* such as grease, oil, gasoline, or paint.
- A **Class C fire** is *electrical*.
- A **Class D fire** is a *flammable metal* such as magnesium or potassium.
- Either *carbon dioxide (CO<sub>2</sub>)* or a *dry chemical* fire extinguisher can be used on *Class B and C fires*.

A gauge on the top of the fire extinguisher tells whether it is fully charged or if the charge pressure has leaked off. Fire extinguishers in business establishments are periodically inspected by the local fire department or a fire extinguisher service company, but be sure to check the gauge on the extinguisher on a regular basis.

For auto repair shops, the size should be at least a 20B (this number designation is explained later). A popular fire extinguisher that people keep in their vehicles or boats is a 2A-10BC:

- The 2A means that the extinguisher can put out a 2 cubic foot fire of a material like paper.
- The 10B means that it can put out 10 square feet of burning liquid.



Be sure to have a large enough fire extinguisher on hand. An engine compartment fire often requires a larger extinguisher, depending on how far the fire has progressed.

- The C means that electrical fires can be extinguished.

Locate and check the type of fire extinguisher(s) in your shop. They should be located in a place *other* than where the most likely start of a fire would be. For

instance, do not locate a fire extinguisher right over the welding bench or next to the solvent tank. If a fire began there, you would not be able to get to the extinguisher. Locating fire extinguishers on both sides of a common work area is a good idea.

### FLAMMABLE MATERIALS

Greasesweep and rags soaked in oil or gasoline should be stored in covered metal containers (Figure 3.8). Keeping oily materials separated from air prevents them from self-igniting, a process called *spontaneous combustion*. Flammable materials should be stored in a flammable storage cabinet (Figure 3.9).

Used greasesweep is kept in a flammable storage container because it may be reused until it becomes saturated (wet). Saturated greasesweep must be disposed of using a licensed waste hauler.



Figure 3.8 Keep combustibles in safety containers.



Figure 3.9 An approved flammable storage cabinet. (Courtesy of Justrite Manufacturing)

### FUEL FIRES

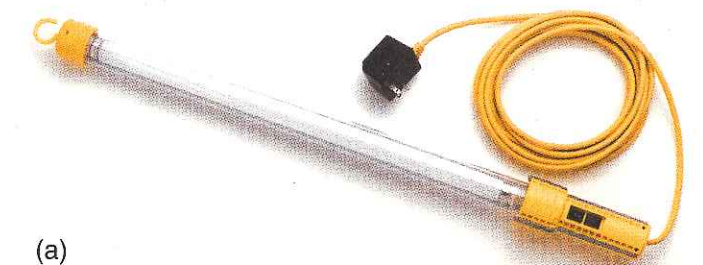
Gasoline is a major cause of automotive fires. Liquid gasoline is not what catches on fire. Rather, it is the *vapors* that are so dangerous. Gasoline vapors are heavier than air, so they can collect in low places in the shop. They can be ignited by a spark from a light switch, a motor, electrical wires that have been accidentally crossed, or a dropped shop light.



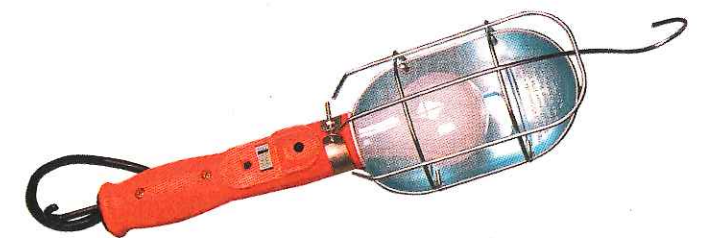
**CAUTION** Cold fuel spray can cause a bulb to shatter and the hot filament can start a very dangerous fuel fire.

There are two kinds of shop lights (Figure 3.10). One of them has a fluorescent bolt enclosed in a plastic tube. The other uses an incandescent lamp, or a light bulb. A fire hazard exists when using an incandescent lamp around a fuel system, especially high-pressure ones.

Rubber-coated bulbs, which are available, will reduce the chances of scattering glass if the bulb is broken, but the recommended style of shop light to be used around automobiles is the one enclosed in a plastic tube or an ordinary flashlight.



(a)



(b)

Figure 3.10 Two kinds of drop lights. (a) A fluorescent tube safety light. (b) The light shown here should be used with a shatterproof bulb. (Courtesy of Woods Industries, Inc.)

### Gasoline Safety

1. Gasoline should be stored only in an approved safety container (see Figure 3.9) and never in a glass jar.
2. Never use gasoline to clean floors or parts. Parts cleaning solvent (Stoddard solvent is the industry term) has a higher **flash point** than gasoline. A flammable liquid's flash point is the temperature at which the vapors will ignite when brought into contact with an open flame.
3. Careless cigarette smoking or failing to immediately and thoroughly clean gasoline spills can contribute to a dangerous situation. People get used to working around gasoline and then begin to ignore how dangerous it can be.
4. Do not attempt to siphon gasoline with your mouth. Accidental breathing of gasoline into the lungs can be fatal.

A fire will go out if the source of oxygen is removed or if the temperature is lowered below the fuel's flash point. Firefighters can use a fog of water to cool a fuel fire and cut off its oxygen, but shop personnel should be knowledgeable about fire extinguishers and how to use them.

**NOTE:** Do **not** attempt to douse a fuel fire with water. Water will cause the fire to spread because fuel is lighter than water and floats on top of it.

### CASE HISTORY

A technician completed the installation of a rebuilt engine. When he started the engine, the float in the carburetor stuck. The results were gasoline pouring out of the carburetor, and an air-fuel mixture that was too rich. When the engine "popped back" through the carburetor, a fire began. The technician grabbed a nearby hose and attempted to douse the fire. The water only served to spread the flames. The result was a total loss of the vehicle.

### NOTES:

- **Backfire** is a term for combustion that occurs in the vehicle's exhaust (after it leaves the cylinder).
- **Popback** is a term for combustion occurring in the fuel induction system (before it enters the cylinder).

### ELECTRICAL FIRES

Electrical fires are prevented by disconnecting the battery before working on the electrical system or around electrical components, such as the starter or alternator (**Figure 3.11**). Unbolt the ground cable first. This prevents the possibility of a spark occurring if a wrench accidentally completes a circuit between a "hot" cable and ground.



**Figure 3.11** Remove the battery ground cable first.

**NOTE:** The ground cable is the one that is bolted to the engine block. Do not assume that ground is the negative cable. On some older vehicles, the positive cable is ground.

If there is an electrical fire, the battery must be disconnected as fast as possible so the fire can be put out. Another advantage to removing the ground cable is that an electric cooling fan cannot accidentally come on while working near it.

### SHOP HABITS

The shop can be kept cleaner if a technician gets into the habit of using a shop towel when working. Greasy, oily tools and hands should be wiped clean, preventing the mess from being spread around the rest of the shop. Shop towels sometimes have metal burrs from machining operations. These are not removed by laundering (**Figure 3.12**). Do not rub your face or hands with a shop towel before carefully inspecting it.



**Figure 3.12** Metal burrs are often found in laundered shop towels. (Courtesy of Tim Gilles)

### CASE HISTORY

An apprentice was removing a clutch from a car. After raising the vehicle on the lift, he began to remove the starter motor while the battery was still hooked to the circuit. He did not disconnect the wiring, which was in an inaccessible location on the top of the starter. When the unbolted starter came loose, bare electrical terminal ends became wedged against the frame, which resulted in a major electrical fire. The technician working next to him rushed over with a bolt cutter and cut the battery ground cable near where it was bolted to the block. Damage to the vehicle was limited to a wiring loom and the alternator. The apprentice went to the emergency room to be treated for burned hands and respiratory irritation from inhaling noxious smoke when the insulation on the wires caught fire.

Common sense around the shop dictates that spills be cleaned up as soon as they happen. Oil and solvent spills can be cleaned up with an absorbent material, such as rice hull ash or kitty litter **greasesweep**. Greasesweep is swept up and reused until it becomes too wet (**Figure 3.13**). It is better to use it when it is slightly wet, because the dust that results when using new greasesweep is avoided.

One of the results of environmental regulation is that greasesweep is classified as hazardous if it is used to soak up used engine oil. Waste disposal companies provide a service where superabsorbent cloths are used to soak up spills. The disposal companies then collect the cloths for proper treatment.

**NOTE:** Because saturated greasesweep could be flammable, it must be stored in a metal can with a lid.

Newer materials that are now being used instead of greasesweep are bioremediation oil absorbent products. These products have microbes that "eat" oil or fuel,



**Figure 3.13** Greasesweep is used to absorb spills. (Courtesy of Tim Gilles)

converting it to harmless CO<sub>2</sub> and water. Concrete floors cleaned with this material are left clean and slip resistant. The biggest advantage to this method is that the need for hazardous disposal is reduced or eliminated.

There are also nontoxic water-based degreasers.

### HAZARDOUS MATERIALS

Some materials routinely used in the shop may be dangerous to your health. In addition, many chemicals irritate skin. Cautions about skin and eye protection are covered throughout this chapter. A material is considered *hazardous* if it causes illness, injury, or death or pollutes water, air, or land.

Hazardous materials that automotive technicians commonly come into contact with include:

- Cleaning chemicals (carburetor cleaner, solvents, caustics, acids)
- Battery acid
- Fuels
- Paints and thinners
- Used oil and fluids
- Heavy metals
- Antifreeze/coolant
- Asbestos (brakes and clutches)
- Refrigerants

Many states publish pamphlets that specifically address the proper disposal of wastes generated in automotive repair shops. Many modern automotive repair shops use equipment specifically to reduce the generation of hazardous wastes. Some of these include coolant recyclers, air conditioning refrigerant recyclers, oil filter crushers, pyrolytic baking ovens, and waste oil furnaces for shop heating.

In the United States, materials that can harm workers and the environment are regulated by the following three agencies:

- The charge of the Environmental Protection Agency (EPA) is to protect the land, air, and water from hazardous materials.
- The National Institute of Occupational Safety and Health (NIOSH), formerly OSHA, manages the protection of workers from unsafe workplace hazards, including hazardous materials.
- The Department of Transportation (DOT) oversees the transportation of hazardous materials.

The EPA characterizes hazardous waste in two ways and has developed a list of over 500 specific hazardous wastes. A material is a hazardous waste if it is on this list or if it exhibits a characteristic from one of four categories: ignitability, corrosivity, reactivity, or toxicity. The following are examples of hazardous wastes from these four categories.

- **Ignitable wastes** burn readily. These materials have a flash point of less than 140°F. Automotive products such as cleaning solvents, paint solvents, degreasers, and gasoline are examples of ignitable materials.

- **Corrosive wastes** burn the skin or corrode metals or other materials. They have a pH of lower than 2 or higher than 12.5. Examples include rust removers and acid or alkaline cleaning liquids.
- **Reactive wastes** are unstable and react rapidly or violently when combined. A good example of reactive wastes include ammonia and bleach, which combine to form phosgene gas (nerve gas). There are hardly any reactive wastes used in the automotive industry. Acetylene (used in gas welding) is an example of a reactive substance.
- **Toxic wastes** are often described as anything you cannot safely eat or drink. Examples of toxic wastes include aerosol spray paints and fuel system or brake cleaners that are commonly used in most automotive shops (**Figure 3.14**). Some products contain chlorinated compounds, and most contain various toxic organic chemicals, such as methyl ethyl ketone (MEK), acetone, methylene chloride, trichloroethane, toluene, and heptane. Some are hazardous air pollutants (HAPs), and chlorinated solvents are a threat to the earth's protective ozone shield. Other automotive pollutants on the EPA's air contaminant list include carbon monoxide from car exhaust and chlorofluorocarbon (CFC) from older air-conditioning refrigerants.

Petroleum-based solvents can cause nervous system damage, and some are carcinogens (potentially causing cancer). Wastes are also toxic if they contain certain heavy metals such as chromium, lead, or cadmium.

### Bloodstream Hazards

Hazardous materials can enter the bloodstream through the lungs by breathing fumes. Some materials can pass right through a respirator. Asbestos is a good example. Asbestos fiber is so small that a special filter called a high-efficiency particulate air (HEPA) filter is required for breathing protection. Asbestos is known to cause



**Figure 3.14** A contents label from a spray paint can. (Courtesy of Tim Gilles)

damage to lungs and has been linked to a specific cancer of the lung cavity.

**Problems with Spray Cleaners.** Aerosol spray cleaners tend to be more hazardous to your health because they enter the bloodstream when breathed. The base from which many spray brake cleaners is made is perchloroethylene (PERC). Other brake cleaners are volatile organic compound (VOC)-based solvents. These include xylene, toluene, and hexane.

- PERC is a carcinogen.
- Xylene causes birth defects.
- Toluene causes central nervous system damage.
- Hexane is a neurotoxin.

**NOTE:** *Water-based cleaners are preferable, especially in brake work. Some water-based cleaners contain solvents such as alcohol, terpenes, and glycol ethers, some of which may be toxic and damaging to hands. There are effective water-based cleaners that do not have solvent additives.*

Hazardous materials can also be ingested by eating or drinking. The skin protects the bloodstream from most liquids. However, the molecules of some toxic liquids are smaller than the membrane of human skin that allows sweat to escape. These liquids can, and do, penetrate the skin and enter the bloodstream. Always wear protective gloves to protect yourself. Be certain the gloves provide the necessary amount of protection. Some gloves can allow the same materials that can penetrate your skin to pass through. Obviously, materials can enter the bloodstream unimpeded by the skin if you have a cut or scrape.

**NOTE:** *Many technicians routinely wear blue nitrile gloves on their hands at all times. Nitrile gloves are not damaged by most solvents. They also provide some measure of protection from skin damage and penetration through the skin by solvents.*

### Skin Damage

Automotive technicians often receive chronic exposure to cleaning materials. Using petroleum-based solvent to clean parts by hand without using gloves is one example. Years of this abuse can result in a painful condition in which hands are cracked, often bleed, and the skin peels off. This is called dermatitis. It can also be caused by using the wrong soap for the soil being cleaned. There are hand lotions and creams formulated for use to correct dermatitis. Be sure to wash your hands thoroughly before applying a lotion or cream.

**NOTE:** *If your employer provides you with personal protective equipment (PPE), you are required to use it. Eye protection is one example. NIOSH Regulations Section 29 CFR 1910.133 (a) (1) says, "each affected employee shall use eye or face protection when exposed to eye or face hazards from flying particles, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapors, or potentially injurious light radiation" (such as arc welding).*

## HAZARDOUS COMMUNICATION STANDARDS

In the United States, the EPA outlines regulations for the disposal of hazardous materials. These regulations are called the **Hazard Communication Standards**.

Companies must develop a hazardous waste policy, and each hazardous waste generator must have an EPA identification number. When waste is transported for disposal, a licensed waste hauler must transport and dispose of the waste. A copy of the written manifest—an EPA form—must be kept by the shop.

The Hazard Communication Program requires chemical manufacturers to publish information about the chemicals they produce and distribute. The employer then provides information by labeling materials and training employees in their proper uses. The label on a hazardous material must include the product manufacturer's name and address, its chemical name and trade name, and safety information about the chemical.

## MATERIAL SAFETY DATA SHEETS

For any hazardous materials used, an employer must make available to employees a Material Safety Data Sheet (**MSDS**) (**Figure 3.15**). An MSDS provides details of the composition of a chemical, lists possible health and safety problems, and gives precautions for its safe use. A supplier of a chemical is required by law to provide an MSDS upon request.

HEXANE	
MSDS Safety Information	
Ingredients	
Name: HEXANE (N-HEXANE)	
% Wt: >97	
OSHA PEL: 500 PPM	
ACGIH TLV: 50 PPM	
EPA Rpt Qty: 1 LB	
DOT Rpt Qty: 1 LB	
Health Hazards Data	
LD50 LC50 Mixture: LD50:(ORAL,RAT) 28.7 KG/MG	
Route Of Entry Inds: Inhalation: YES	
Skin: YES	
Ingestion: YES	
Carcinogenicity Inds: NTP: NO	
IARC: NO	
OSHA: NO	
Effects of Exposure: ACUTE INHALATION AND INGESTION ARE HARMFUL AND MAY BE FATAL. INHALATION AND INGESTION MAY CAUSE HEADACHE, NAUSEA, VOMITING, DIZZINESS, IRRITATION OF RESPIRATORY TRACT, GASTROINTESTINAL IRRITATION AND UNCONSCIOUSNESS. CONTACT WITH SKIN AND EYES MAY CAUSE IRRITATION. PROLONGED SKIN CONTACT MAY RESULT IN DERMATITIS (EFTS OF OVEREXPOSURE).	
Signs and Symptoms of Overexposure: HLTH HAZ:CHRONIC:MAY INCLUDE CENTRAL NERVOUS SYSTEM DEPRESSION.	
Medical Cond Aggravated by Exposure: NONE IDENTIFIED.	
First Aid: CALL A PHYSICIAN. INGESTION: DO NOT INDUCE VOMITING. INHAL: REMOVE TO FRESH AIR. IF NOT BREATHING, GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN. EYES: IMMEDIATELY FLUSH W/PLENTY OF WATER FOR AT LEAST 15 MINS. SKIN: IMMEDIATELY FLUSH W/PLENTY OF WATER FOR AT LEAST 15 MINS WHILE REMOVING CONTAMD CLTHG & SHOES. WASH CLOTHING BEFORE REUSE.	
Handling and Disposal	
Spill Release Procedures: WEAR NIOSH/MSHA SCBA & FULL PROT CLTHG. SHUT OFF IGNIT SOURCES. NO FLAMES, SMKNG/FLAMES IN AREA. STOP LEAK IF YOU CAN DO SO W/OUT HARM. USE WATER SPRAY TO REDUCE VAPORS. TAKE UP W/SAND OR OTHER NON-COMBUST MATL & PLACE INTO CONTNR FOR LATER (SU PDAT).	
Neutralizing Agent: NONE SPECIFIED BY MANUFACTURER.	
Waste Disposal Methods: DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE AND LOCAL ENVIRONMENTAL REGULATIONS. EPA HAZARDOUS WASTE NUMBER: D001 (IGNITABLE WASTE).	
Handling and Storage Precautions: BOND AND GROUND CONTAINERS WHEN TRANSFERRING LIQUID. KEEP CONTAINER TIGHTLY CLOSED.	
Other Precautions: USE GENERAL OR LOCAL EXHAUST VENTILATION TO MEET TLV REQUIREMENTS. STORAGE COLOR CODE RED (FLAMMABLE).	
Fire and Explosion Hazard Information	
Flash Point Method: CC	
Flash Point Text: 9F, 23C	
Lower Limits: 1.2%	
Upper Limits: 17.7%	
Extinguishing Media: USE ALCOHOL FOAM, DRY CHEMICAL OR CARBON DIOXIDE. (WATER MAY BE INEFFECTIVE).	
Fire Fighting Procedures: USE NIOSH/MSHA APPROVED SCBA & FULL PROTECTIVE EQUIPMENT (FP N).	
Unusual Fire/Explosion Hazard: VAP MAY FORM ALONG SURFS TO DIST. IGNIT SOURCES & FLASH BACK. CONT W/STRONG OXIDIZERS MAY CAUSE FIRE. TOX GASES PRDCEED MAY INCL: CARBON MONOXIDE, CARBON DIOXIDE.	

**Figure 3.15** A material safety data sheet (MSDS).

In addition to your local parts supplier, the Internet is a good source for accessing MSDSs. Typical shop practice is to obtain pertinent MSDSs and keep them in a binder where employees can have access to them. An MSDS must include any hazardous materials that are contained in a product. It lists the percentage of the product that is made up of each of the product's hazardous ingredients. For instance, a typical carburetor cleaner spray might be made up of 45% toluene, 20% acetone, and so on.

### Interpreting an MSDS

The MSDS lists the *permissible exposure limit (PEL)* and the *threshold limit value (TLV)* of various vapors, dusts, or fumes. Exceeding the limit can result in illness or injury. Short-term exposure limits (STEL) are also included. The STEL is the maximum amount of exposure during a 15-minute period in one 8-hour workday.

**NOTE:** *The smaller the exposure limit on the MSDS, the more toxic the chemical is. NIOSH lists an exposure limit called immediately dangerous to life and health (IDLH).*

Be aware that exposure limits are simply estimates of danger for short-term exposure. There is no guarantee that you will not suffer long-term damage if you are regularly exposed to a chemical at a level that is less than the STEL.

Flammable limits for a material are also listed on an MSDS. LEL is the *lower explosive limit* of a material. This represents the lowest vapor concentration of a material that will ignite. Leaner mixtures than the LEL will not burn. UEL stands for the upper explosive limit. Concentrations richer than the UEL will not burn. Some chemicals list LFL and UFL standards. These are the same, except they mean lower flammable limit and upper flammable limit, respectively.

## HAZARDOUS MATERIALS COMMON TO THE AUTOMOTIVE INDUSTRY

### Solvents

Solvents are very popular for cleaning automotive parts. A solvent is a liquid organic chemical compound used to dissolve solid substances. Most are made from petroleum or synthetic materials. Solvents can dissolve plastics and resins such as those used in gaskets and sealers. They also evaporate quickly, leaving relatively little residue. Evaporation rate is important to the application. Gasket cements and paints must dry quickly. That is why solvents used in them have high evaporation rates.

Solvents are popular in the workplace because they work very well and make jobs go much faster. All solvents are toxic to a certain extent, however, and must be treated with respect if they are to be used. Used correctly, solvents can be very handy tools. Always read the MSDS!

### Hazards Related to Solvents

In chemistry, classes are groups of chemicals with similar properties and molecular structures. There are several chemical classes of solvents, including aliphatic, aromatic and chlorinated hydrocarbons, alcohols, esters, and ketones. Most solvents are flammable, and some can explode. Some can react with other substances or heat to create a different hazardous material.

**NOTE:** Chlorinated solvents are not flammable but when exposed to flame can become phosgene gas. Phosgene gas is the nerve gas that killed so many soldiers in World War I.

Symptoms of solvent exposure can show up immediately, acute symptoms, or they can arise later, chronic symptoms or effects. Acute symptoms include rashes and burns, nausea, or headaches. Solvents can cause irritation and damage to your skin, eyes, and respiratory tract, including the nose and throat. Continued irritation can result in chronic bronchitis and other lung diseases. These types of effects are called "local effects" because the harm is caused at its original point of contact.

All organic solvents can cause skin problems. Repeated contact causes the skin's protective fats and oils to dissolve. When the skin's protective barrier is removed, it becomes dry and cracked, leaving it vulnerable to absorption of toxic materials. Some solvents, such as MEK, can be absorbed through the skin. When a chemical enters the body in this way, it can travel to other organs, such as the liver, kidneys, muscles, heart, or brain. This type of exposure is called "systemic." Liver and kidney damage can result from systemic chemical exposure. The liver converts solvents to less toxic substances. The kidneys filter the results of that conversion and prepare them to leave the body. The liver and kidneys can be damaged by the substances they are attempting to eliminate.

Chronic effects are also called latent effects. They can be caused by repeated exposure over time or can result from a single exposure. Latent effects can take weeks or even years to show up. Chronic effects are often irreversible. These include cancer, heart disease, blood disease, and potential birth defects. Symptoms of chronic exposure to dangerous chemicals are documented over time. Heart damage was linked to solvents during a 5-year period when more than 100 people died from sniffing solvents.

Benzene, heptane, trichloroethylene, and methylene chloride are some of the chemicals that can cause arrhythmias. Arrhythmia is a term that applies to abnormal patterns in a heart's pumping cycle. Tetrachloroethylene, also called perchloroethylene or perc, and toluene have been implicated as spontaneous abortion risks in fathers who have been exposed to it in the workplace.

Some solvents can cause neurological symptoms such as narcosis. Central nervous system involvement

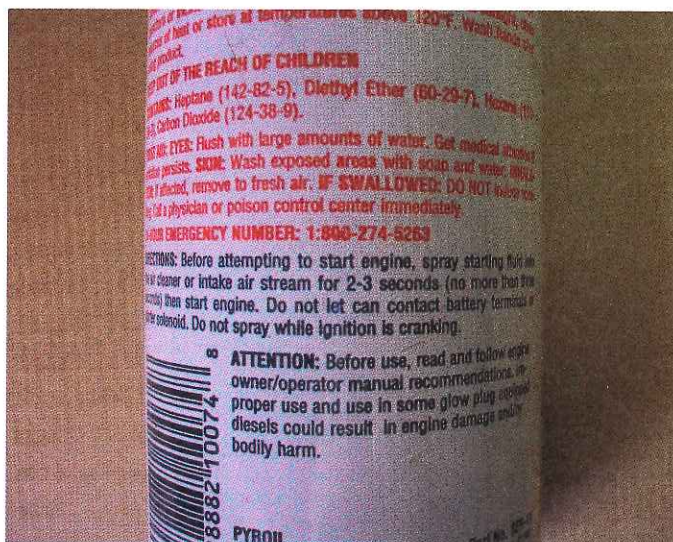
can result in narcosis, or unconsciousness, dizziness, headaches, fatigue, and nausea. At high concentrations, symptoms can mimic drunkenness, followed by death.

The most common solvents in the automotive industry include hexane, mineral spirits, xylene, toluene, heptane, and petroleum naphthas. Hexane is found in gasoline, rubber cements, and many spray products. Check the label on the container (**Figure 3.16**) and read the MSDS. Hexane can affect the central and peripheral nervous systems. Peripheral nervous system involvement causes a slowing of the speed of nerve impulses from the spine to the arms and legs accompanied by numbness, weakness, or paralysis. This is called peripheral neuropathy. Symptoms can be similar to multiple sclerosis. Another disorder of the peripheral nervous system is polyneuropathy. Symptoms include muscle spasms, leg pain and weakness, and tingling in the arms. Solvents implicated as possible causes include benzene, n-hexane, n-heptane, and toluene.

Sometimes two or more substances react with one another and can become more hazardous. This is called synergism. One example is the higher instance of health problems among asbestos workers who also smoke. In another example, when MEK is combined with n-hexane, severe nerve damage can result. Carbon tetrachloride causes serious liver damage, especially when combined with alcohol.

Heptane is a central nervous system depressant. Dizziness and loss of coordination are the result of short-term exposure, which is 2,000 parts per million for 4 minutes. Long-term exposure can result in minimal peripheral nerve damage.

Some solvents are known to cause cancer in humans and animals. Benzene can cause leukemia. Experts suspect that chlorinated solvents—those whose names include "chloride" or "chloro"—might be carcinogens



**Figure 3.16** This contents label is from a can of starting fluid spray. (Courtesy of Tim Gilles)

and cause cancer. Twenty-one human carcinogens are regulated by NIOSH. There are hundreds of other suspected carcinogens under investigation.

Mutagens are chemicals that affect the genetic material in human cells. The result of exposure to a mutagen can include damage to sperm or egg cells, which can prevent conception. If conception does happen, a miscarriage or damage to the fetus can occur. A teratogen is a chemical that affects the development of a fetus. A fetus is often more sensitive to chemicals than its mother.

When dealing with hazardous materials, the most prudent course of action is to avoid contact altogether. If a part can be cleaned in a contained tank without dangerous contact to you, use this method whenever practical.

### SAFETY NOTE

Be aware of the materials you are dealing with. Remember, no one will be more concerned for your safety and health than **you!**

### HOT TANK SAFETY PRECAUTIONS

#### Caustic or Acid Cautions

In addition to burns that can occur due to the high temperature of the solution, caustic solution from a hot tank can also eat your skin and cause blindness.

#### Hot Tank Safety

1. Always wear gloves and face protection when working around caustics.
2. If caustic contacts your skin, rinse immediately and seek medical attention.
3. If caustic gets into an eye, the caustic must be flushed from the eye immediately or blindness may result. Be sure to lift the eyelid and flush under it with water for 15 minutes. Continue repeated 15-minute washings while medical attention is sought.
4. Articles should be lifted from the tank with a lifting device. People have fallen into large hot tanks while trying to retrieve objects by hand.
5. Be sure that lifting slings are securely fastened to items in the tank. Failure to do so can cause a dangerous splash.

### CLEANING SOLVENT SAFETY PRECAUTIONS

#### Cleaning Solvent Cautions

Cleaning solvents are used extensively in auto repair. Their use is generally safe provided the user has knowledge of hazards associated with them. A flammable

liquid's flash point is the temperature at which it will catch fire. Stoddard solvent has a relatively high flash point, but fires can still result.

### Cleaning Solvent Safety

1. Use eye protection.
2. Do not breathe vapors.
3. Clean only in areas with adequate ventilation.
4. Wear a respirator if using a blowgun to apply a chemical. (Nontoxic chemicals are available.)
5. Do not clean with gasoline. It is very explosive when it vaporizes.
6. Some solvents can catch fire on a hot engine. Be sure to use a nonflammable solvent.
7. Do not spray solvents if near any pilot lights.
8. Use a brass or nylon brush instead of a steel wire brush to avoid the possibility of an accidental spark.
9. The lid on the solvent tank should always be kept closed when not in use to prevent a fire hazard.
10. Do not smoke or weld anywhere near solvent.

### SKIN CARE SAFETY PRECAUTIONS

Many solvents are damaging to skin. **Dermatitis** (irritated skin) can result from exposure. If hands are burned or swollen from solvent contact, seek medical attention.

- Do not put hand creams on the skin as treatment. Hand cream can seal in the solvent irritant, causing even more damage.
- Be sure the gloves you use do not allow penetration by the solvent being used. Neoprene, an oil-resistant artificial rubber commonly used for hoses and gloves, protects against some types of solvents, but not others. Latex, a material commonly used in making the surgical gloves popular with many mechanics, will also allow penetration by some chemicals.
- Do not mix other chemicals with cleaning solvents.

To aid in cleaning hands, **barrier creams** are sometimes rubbed on the skin prior to working in a greasy environment. Although these creams are quite effective in making hand cleaning easier, they do not protect the skin against penetration by solvents and are not a substitute for gloves.

### BREATHING SAFETY

There are many sources of breathing hazards. These can include paints, cleaning chemicals, burned wire insulation, grinding dust, asbestos, vehicle exhaust, and battery gas. Some of these hazards are only breathed by accident. Others are in the air and must be guarded against. Some are only dangerous after long-term exposure.



**Figure 3.17** Use an exhaust ventilation system when working around a running engine. (Courtesy of Tim Gillies)

Sometimes you will need to work around a running engine. Be sure the parking brake is firmly applied and try to stand to the side of a running vehicle. Exhaust gas can contain large amounts of carbon monoxide. Protect yourself and others from exhaust gas by using an exhaust system (**Figure 3.17**).

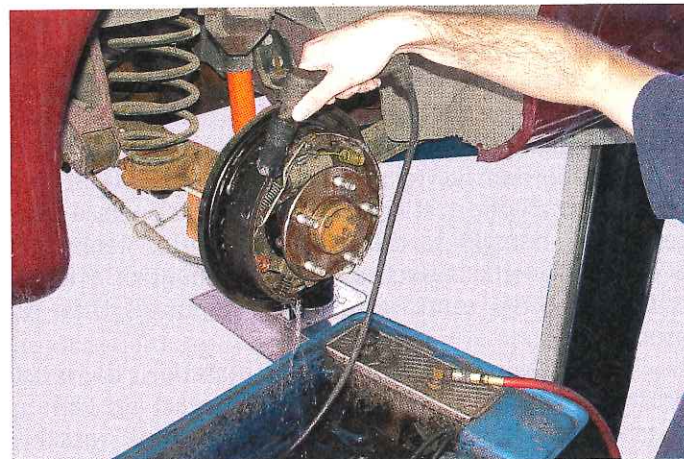
**Asbestos**

Asbestos, found in some brakes, clutches, and cylinder head gaskets, is dangerous to breathe. In fact, the respirator shown in **Figure 3.18** will probably not completely protect your lungs from asbestos fibers. Dry brushing is expressly prohibited during brake cleaning. Using a drill-operated wire brush to clean fiber head gaskets can also release asbestos into the air. When working on brakes or clutches or when removing head gaskets from cylinder head surfaces, one of two approved methods can be used:

- A popular asbestos cleaning method is to use water with an organic solvent or wetting agent (**Figure 3.19**).



**Figure 3.18** This respirator will not provide complete protection from asbestos. (Courtesy of Tim Gillies)



**Figure 3.19** Cleaning brakes with a water-based cleaner. (Courtesy of Tim Gillies)

- Another asbestos cleaning method is to use a special apparatus (called a **HEPA vacuum**). It vacuums asbestos and captures the particles in a special filter. A regular vacuum will not do. Asbestos will go right through it.

HEPA stands for *high-efficiency particulate air*. A HEPA vacuum completely encloses the brake drum or disc assembly. Gloves and a window allow the technician to clean the brake or clutch assembly. After using the vacuum to suck up loose material, other particles are dislodged using compressed air and are sucked into the vacuum.

**SAFETY NOTE** Be sure to inspect the enclosure to see that it is tight against the brake backing plate before beginning work.

**Asbestos Disposal**

A vacuum filter that is full must be wetted with a mist of water before removing it from the vacuum. Filters must be placed in impermeable containers, labelled, and disposed of in the manner prescribed by law.

When using the liquid method of asbestos protection, the wetting agent must flow through the brake drum *before* the drum is removed. When a drum is removed first, a quantity of asbestos can escape into the surrounding air. A catch basin is positioned under the brake assembly. After the drum is removed, the brake parts are thoroughly wetted before starting to clean. If the system has a filter, it must be disposed of in the same way as a HEPA filter.

An alternative method for shops that do fewer than five pairs of brakes or clutches in one week allows a low-pressure water system or fine-mist spray bottle to be used to wet the parts before beginning work. All parts are then wiped clean with a cloth, which

must be disposed of in an approved, properly labeled container or laundered in a way that prevents the release of asbestos fibers. Dry brushing is prohibited in this method also.

**ELECTRICAL SAFETY PRECAUTIONS**

**Electric Shock**

Twelve-volt direct current (DC) electrical systems, like the ones used in automobiles, do not cause serious electrical shock (unless the engine has a distributorless ignition). Shop equipment, however, is powered by either 110V or 220V alternating current, which can be very dangerous.

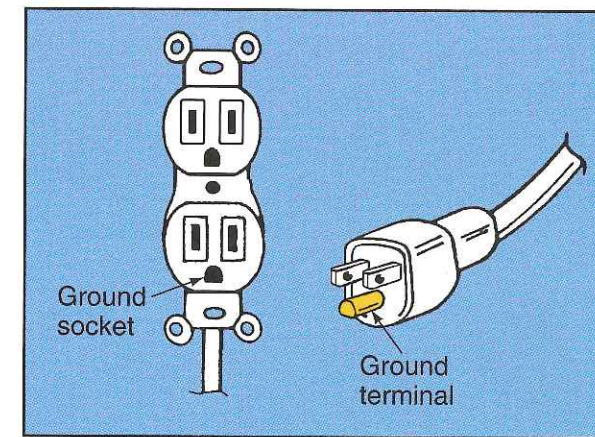
**Electrical Safety**

1. Do not stand in water when using electric tools.
2. Be sure that a tool is turned off before plugging it in so that a spark does not jump from the outlet to the plug.
3. Electrical wall outlets should be properly grounded.
4. Three-wire electrical tools are the best choice for commercial work. The extra terminal is for ground (**Figure 3.20**). If you use a homeowner-type tool with a two-wire plug, it should be *double-insulated*.
5. Be sure to observe electrical wire color coding when repairing or replacing power cords on electric tools.

Hybrid electric vehicles (see Chapter 16) are also a potential source of dangerous high voltage. In these vehicles, high-voltage cables and connections are colored orange.

**CASE HISTORY**

An electrical plug on a drill with a metal housing was damaged and needed to be replaced. A technician bought a new 3-wire plug, cut and stripped the wires, and installed it on the cord. He had been working on cars for many years and was used to the color code used around automotive batteries. Traditionally in automobile wiring, black is ground and red is positive, but in commercial wiring the **green wire is ground**. When he connected the black wire to the ground terminal, he was actually hooking one of the hot leads to ground (also the housing of the metal drill). When he plugged the drill into the wall, he was holding it in his hand and received a dangerous electrical shock. Luckily, he was not seriously injured.



**Figure 3.20** The third wire terminal is for ground.

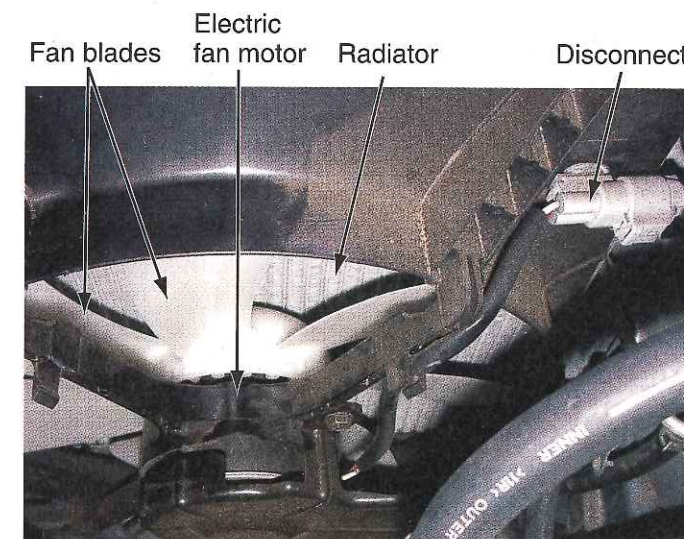
**COOLING FAN SAFETY**

The fan that draws cool air across the radiator can be driven by either a belt or electricity. Rotating fans can be dangerous. Some are controlled by an automatic switch and can start unexpectedly.

1. Electric cooling fans should be disconnected when working around them (**Figure 3.21**).
2. Visually inspect fan blades for damage. A damaged fan blade will probably be out of balance, making it prone to fly apart.
3. Keep hair and clothing away from fans and fan drive belts.

**COOLANT BURNS**

The most likely ways to be burned in an automotive shop are with engine coolant or by the exhaust system. Opening the radiator on a hot engine can be very dangerous. Disc brake rotors can also be hot after a car has recently been driven.



**Figure 3.21** Disconnect the power to an electric cooling fan before working on it. (Courtesy of Tim Gillies)



**Figure 3.22** This arm was badly burned when the technician opened the radiator cap on a hot engine. (Courtesy of Tim Gilles)

If the hose is hard and feels like it is full of coolant, the coolant level is acceptable. If the hose collapses, the coolant is not under pressure but steam can still cause a burn. Exercise extreme caution when opening the cap.

### CASE HISTORY

The radiator cap keeps pressure on the coolant when the engine heats up. When coolant is under pressure, its boiling point is higher. Loosening the cap removes the pressure and the coolant boils instantly. A student had just begun working in a full-service gas station. A customer asked him to check the coolant level in the radiator. When he opened the radiator cap, he turned it 1/2 turn. This defeated the cap's safety feature and the coolant boiled out, severely burning him (Figure 3.22).

### SAFETY NOTE

Always squeeze the top radiator hose before opening a radiator cap (Figure 3.23). When the radiator cap is turned only 1/4 turn, the safety catch will prevent it from coming all the way off, but superheated coolant can escape through the small hose that runs from beneath the radiator cap to the overflow reservoir. With the pressure removed, the coolant in the overflow reservoir will boil violently. When it comes out of the reservoir, it can cause serious burns.

### GENERAL HAND TOOL SAFETY

Cuts and scrapes are common when working on cars. Experienced technicians cut themselves less often than beginners. This is because they use hand tools properly.



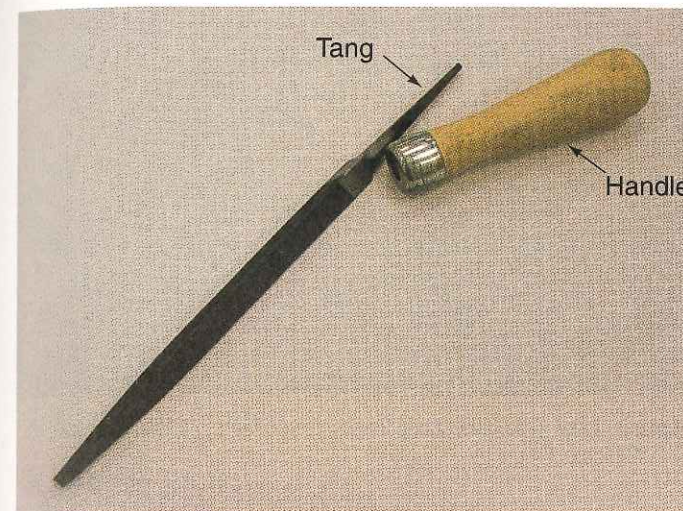
**Figure 3.23** Squeeze the top hose before attempting to remove the radiator cap. (Courtesy of Tim Gilles)

Refer to Chapters 8 and 9 for more information on the particular hand tools and equipment covered here. The following precautions should be used when handling hand tools:

1. Before using a tool, inspect it to see that it is not damaged or cracked.
2. Maintain tools in safe working condition.
3. Do not use worn or broken tools.
4. When using screwdrivers, do not hold small components in your hand in case the blade slips.
5. Do not put sharp tools in your pocket.
6. Be sure to always use eye protection when using hammers and chisels.
7. Mushroomed chisels and punches should be reground before use (Figure 3.24).
8. Be sure that a file has a handle installed on its tang before using it (Figure 3.25).



**Figure 3.24** Regrind a chisel with a mushroomed head. (Courtesy of Tim Gilles)



**Figure 3.25** Install a handle on the tang of a file. (Courtesy of Tim Gilles)

### WISE SAFETY

Be careful not to tighten the vise too much at its wide-open position or the vise might break. Never use a piece of pipe on the handle of a vise; it can break the vise.

### PULLER SAFETY

Pullers can be dangerous, especially if used improperly. Parts that are being separated can be under a good deal of pressure. They can explode, especially when using an impact wrench or a hydraulic puller. The following are some general tips on safe use with pullers:

- Wear eye protection.
- Be sure the puller is aligned so it is perpendicular to the part being pulled.
- Do not use a puller with damaged or worn parts.
- Use the correct size puller so overloading is avoided.
- Use a 3-jaw puller instead of a 2-jaw puller when possible.

### MACHINERY SAFETY

There are many types of machinery used in automotive shops. Common sense will prevent most injuries and accidents.

- Do not talk to someone who is operating a machine.
- Do not talk to someone when you are operating a machine.
- Be cautious when working around a running engine or rotating machinery. Fingers can be cut off by a moving belt and pulley.

**NOTE:** Sometimes, machinery rotating at high speed does not appear to be moving. One example of this is household lighting. House and shop light appear to be constant. However, they are powered by alternating current so they actually flicker at 60 times per second. This can produce a strobe effect on moving machinery.

### ELECTRIC DRILL SAFETY

#### Drilling Safety Precautions

Drills are used often in repairing automobiles. As with other types of machinery, knowledge and common sense will prevent accidents from occurring. The following are some tips on correct use of electric drills:

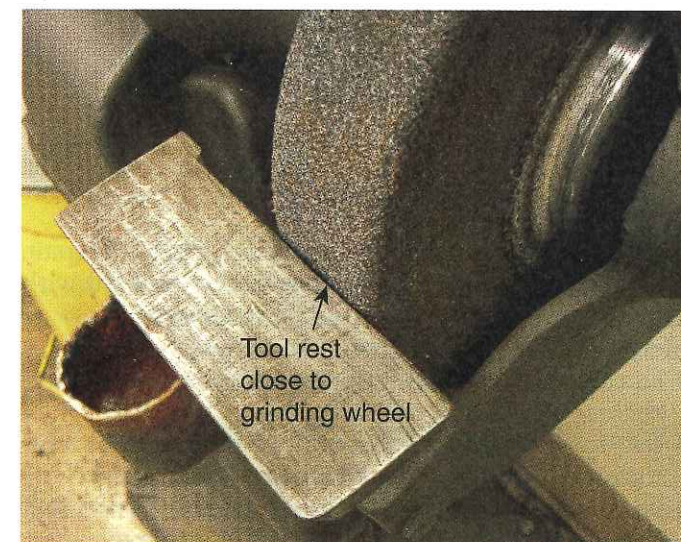
- Always wear eye protection.
- Release pressure occasionally to allow chips to break off before they can become too long and dangerous.
- A drill bit may catch when it starts to break through the work being drilled. Be sure that sheet metal is clamped to the worktable. Let up the pressure on the bit as it starts to break through the bottom of the hole.
- If the drill grabs the work, shut off the drill. Never grab the moving work.
- Be sure to remove the chuck key from the chuck before drilling.
- Never stand in water when drilling. Standing in water increases the danger of electrical shock.

### GRINDER SAFETY

#### Grinder Safety Precautions

The grinder is a part of the machine inventory of all automotive shops. Serious accidents can occur if the grinder is not used properly. If you understand the following safety precautions about the grinder, it can be used safely and effectively:

- Stand to the side when starting the motor. The grinding wheel is more likely to explode during startup because of the inertia of the wheel.
- Wear face protection.
- Position the tool rest as close to the wheel as possible, so that nothing can get trapped between the wheel and the tool rest (Figure 3.26).



**Figure 3.26** Position the tool rest as close to the grinding wheel as possible. (Courtesy of Tim Gilles)

- Use the shield installed on the grinder.
- Do not grind on the side of the grinding wheel.

### WIRE WHEEL SAFETY

#### Wire Wheel Safety Precautions

Most grinders are set up with a wire wheel on one side and a grinding wheel on the other. The wire wheel is used to remove carbon, paint, or rust from parts and to deburr freshly machined parts. To avoid injury, use common sense when dealing with a wire wheel and follow the following precautions:

- Use face protection.
- Wear leather gloves if they are available.
- Do not push too hard against the wheel. Severe finger injuries can result if your hand slips.
- Wire wheels can damage soft aluminum surfaces.

### COMPRESSED AIR SAFETY

#### Compressed Air Tool Safety Precautions

Compressed air is very useful to a technician but can be dangerous when used improperly. Horseplay has no place in a shop. A blast of air can result in a broken eardrum. Blowing compressed air into a body orifice can result in death. The following are compressed air tool safety precautions:

- Always wear eye protection when blowing off parts. Pieces of debris can be blown into eyes.
- Do not blow air against your skin; the high-pressure compressed air used in auto repair shops can penetrate skin.
- Compressed air is used to power chassis grease guns. Pressurized grease can penetrate skin.
- Hold onto the air hose when uncoupling an air line so it does not fly through the air.
- When possible, bleed off the air from an air line before uncoupling an air hose.
- Rubber-tipped blowguns are not safety regulated like other normal blowguns. When held against a part, full shop air pressure is available at the tip.

### IMPACT WRENCH SAFETY

Air impact wrenches are used extensively in auto repair. They save time and make work easier when used with knowledge and common sense. The following are some safety tips when using impact wrenches:

- Be careful of loose clothing or hair that might become tangled in the tool.
- Use approved *impact* sockets, not ordinary chrome sockets, which can break (Figure 3.27).
- Be sure that the socket is secured to the air tool. The clip at the end of the tool's square drive can become worn so that it no longer holds the tool.



Figure 3.27 Regular and impact sockets. (Courtesy of Tim Gilles)

- Do not turn on the impact wrench unless the socket is installed on a nut or bolt, especially when using a wobble socket. The socket can fly off the impact wrench, possibly causing an injury.
- When the impact wrench fails to loosen a fastener, use a large breaker bar.

### AIR CHISEL SAFETY

Examples of uses for air chisels include cutting metal, driving on valve guides, riveting, and replacing front suspension parts. An injury can occur if an air chisel is not used properly.

- Be sure to wear eye protection.
- Before pulling the trigger, be sure to have the tool bit against the workpiece (Figure 3.28). Otherwise, the tool might fly out of the air chisel.

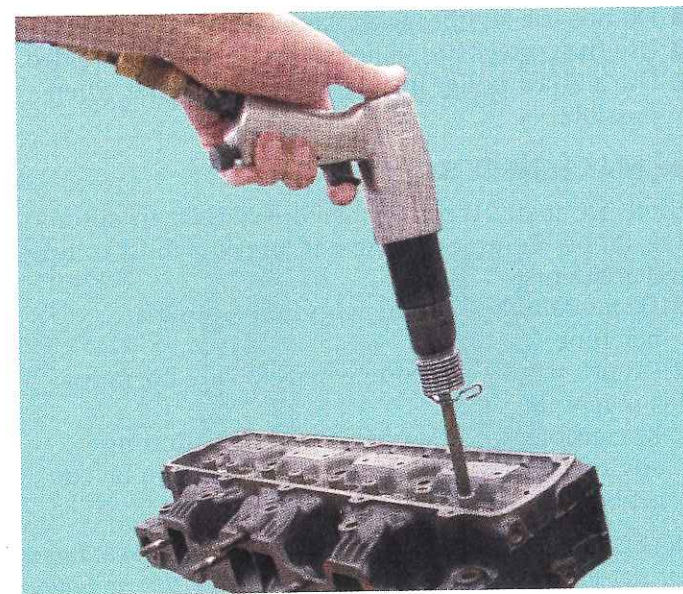


Figure 3.28 Hold the tool bit against the workpiece before pulling the trigger on the air chisel. (Courtesy of Tim Gilles)

### DIE GRINDER/AIR DRILL SAFETY

Air drills and die grinders are used with small grinding wheels, burrs, and wire brushes. A die grinder is similar to an air drill but turns at a much higher speed. There are several safety precautions to use when using these tools:

- The tool is very loud. Use ear protection.
- Die grinders turn at speeds of up to 20,000 rpm. When using a grinding wheel or wire wheel at high speeds, be sure that the wheel is rated for such use.
- Some head gaskets contain asbestos. Do not remove head gaskets using a wire brush and die grinder or air drill.

### PRESS SAFETY

A hydraulic press can be very dangerous, because parts being separated are under such pressure that they can explode. Common automotive presses develop hydraulic force in the range of 20 to 50 tons (40,000–100,000 pounds); see Figure 3.29. Bearings have been known to explode like a bomb, injuring the user with shrapnel. Be sure to use common sense.

- Use applicable safety guards.
- Wear face protection.
- When a press has fast and slow speeds, use the fast speed to press parts whenever possible. This position does not provide full hydraulic pressure.
- Use extreme caution as the pressure applied to the part becomes higher.

### GENERAL LIFTING SAFETY

When lifting a vehicle, be sure that the lift or jack contacts the frame at the recommended lift point (Figure 3.30). To be sure that the vehicle is firmly supported, push on its fenders before going under it.

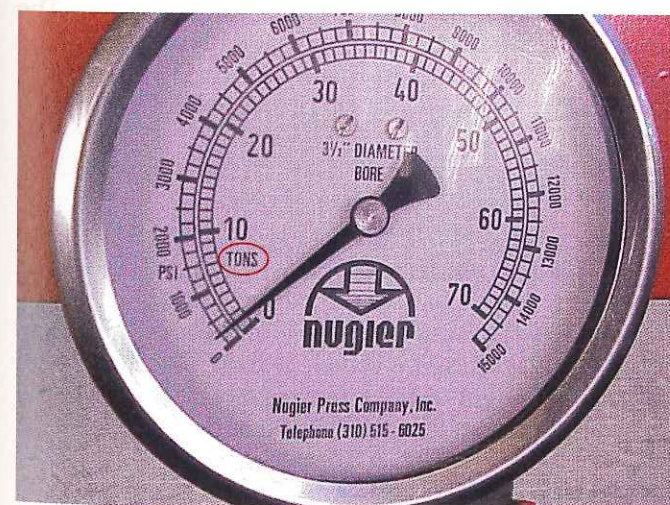


Figure 3.29 The gauge on a typical hydraulic press. How many pounds is 50 tons? (Courtesy of Tim Gilles)

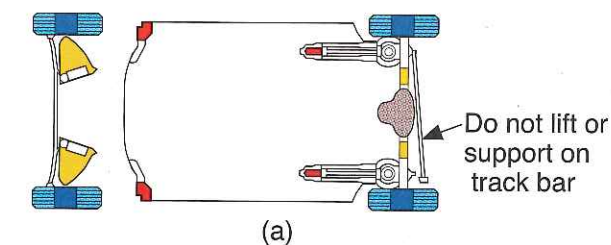


Figure 3.30 Lift a vehicle from one of the lift points shown in the shop service manual.



Figure 3.31 Raise the vehicle a few inches from the floor, then jounce it to be certain it is firmly positioned on the hoist pads. (Courtesy of Tim Gilles)

When lifting a vehicle on a frame-contact hoist, place the lift adapters at the specified locations and raise the vehicle about 6 inches (Figure 3.31). Then, shake it to see that it is firmly placed.

### HYDRAULIC FLOOR JACK (SERVICE JACK) SAFETY

Hydraulic floor jacks (service jacks) are used extensively in automotive repair. Accidents do not occur often, but when they do they can be life threatening. Cars



**Figure 3.32** Always use vehicle support stands when a vehicle is jacked up. (Courtesy of Tim Gilles)

are often serviced while raised on a portable service jack, but this is a dangerous practice. Cars have fallen and crushed people who used jacks that failed. Follow these safety precautions when using a hydraulic floor jack:

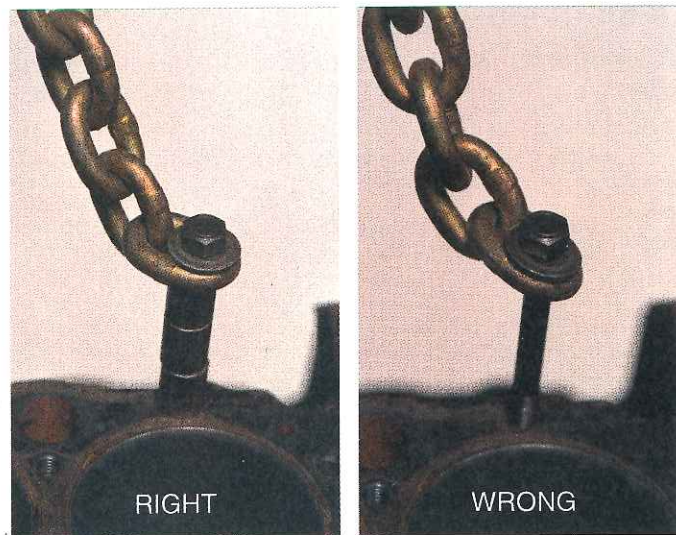
- A hydraulic service jack should be used to raise and lower a vehicle only.
- Always use vehicle support stands (jackstands) (Figure 3.32).
- Use support stands in pairs.
- Be sure that the support stands are positioned in the recommended location on the frame (see Figure 3.30).
- Be sure to use support stands only on a level concrete surface. On a hot day, the legs can dig into asphalt and cause an accident.

**SHOP TIP** Place a piece of thick plywood or a steel plate under support stands that are used on asphalt.

It is foolish to crawl under a vehicle that is not resting *solidly* on vehicle support stands.

### SHOP CRANE (ENGINE HOIST) SAFETY

When using a shop crane (cherry picker), several safety precautions are necessary. An engine is very heavy. It is important that the center of gravity be observed. When the engine is removed from the car, it is usually raised 3–4 feet off the ground to clear the radiator grill. *It is very dangerous to move the shop crane with the center of gravity this high because the crane can tip over easily.* Lower the engine close to the ground, and then roll the crane in as straight a line as possible to avoid tipping it over. This precaution is especially critical when the engine and transmission have been removed at the same time.



**Figure 3.33** The lifting fixture must be firmly tightened against the part to be lifted. The bolt on the right will be under extreme stress, which can cause it to break.

### CASE HISTORY

An apprentice had just removed an engine and transmission from a rear-wheel-drive pickup. The shop crane was still in the high position that was required to clear the front grill and radiator mount. He attempted to move the engine and transmission without first lowering them close to the ground. As he tried to push the shop crane over a ledge at the entrance to the service bay, the balance of the crane was upset and the engine crashed to the ground. Luckily, the only damage was to the transmission oil pan and extension housing. One of the legs of the shop crane was bent so badly that it was taken out of service.

- It is very important that the bolts that hold the engine sling to the engine block are not too short. The amount of thread on the bolt that enters the block should be of an amount that is at least 1½ times the diameter of the screw thread (usually about 6 turns).
- Bolts used to attach a lifting fixture to a heavy part must be firmly tightened against the device. Use spacers if necessary (Figure 3.33).
- Be sure to lower the engine as soon as possible before attempting to roll the crane to a different location.
- When an engine has been removed from a vehicle, be careful when raising the vehicle in the air while on a frame-contact lift. The vehicle will be rear-end heavy when the weight of the engine is removed from it. The result can be that the vehicle falls off the lift.

### TRANSMISSION JACK SAFETY

A transmission jack is used when the vehicle is raised in the air on a lift. The safest use of this jack is when the vehicle is on a wheel-contact lift. When a vehicle is on a frame-contact lift, there is a danger that raising

the transmission can result in the vehicle being lifted off the adapters on the lift. If its balance is upset, the vehicle could be knocked off of the lift.

### BATTERY SAFETY

As a battery charges it gives off explosive hydrogen gas. Sparks must be avoided around batteries, which occasionally explode (Figure 3.34). The most common cause of battery explosions is when someone unhooks a battery charger without turning it off. A battery explosion can cause:

- Damage to skin (from acid thrown by the explosion)
- Permanent or temporary hearing loss
- Blindness

### HISTORY NOTE

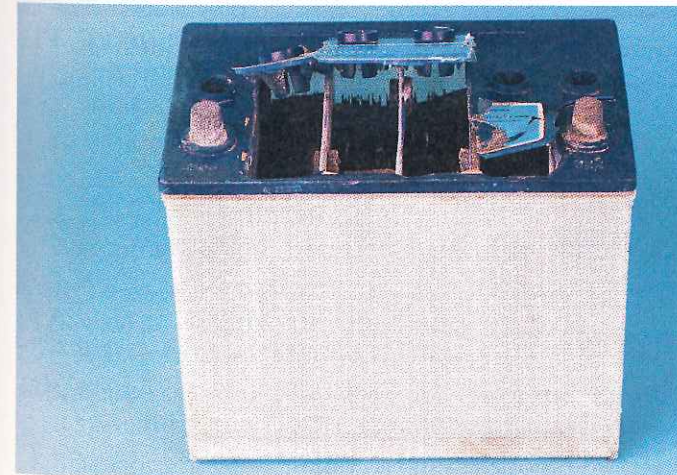
Hydrogen gas is the same gas that was used in the *Hindenburg*, the passenger zeppelin that crashed and exploded in 1937. The space shuttle *Challenger* exploded in 1986 when its liquid hydrogen tank ignited.

### Battery Safety

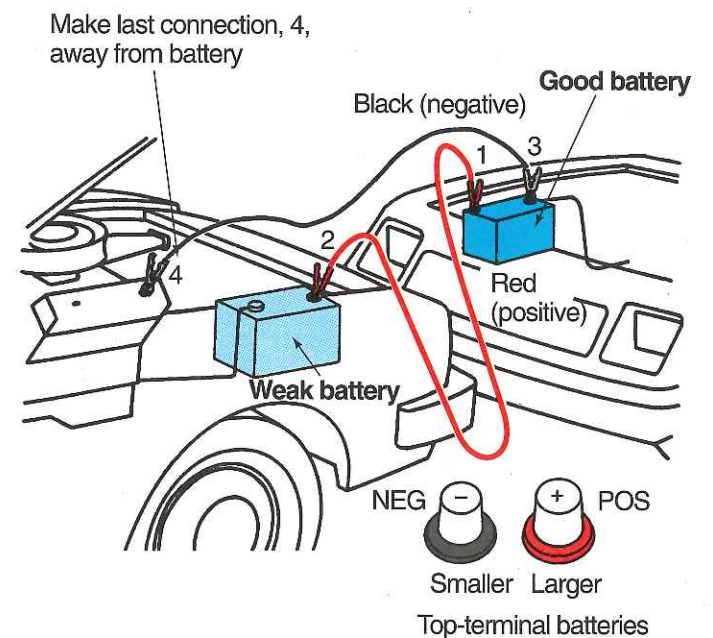
1. Always wear eye protection when working around batteries.
2. Unplug the charger before connecting or disconnecting any of the cables.
3. Be sure to shut off the battery charger before unplugging its 110V power cord, or a spark could happen when the electricity tries to jump from the outlet to the plug.

### Jump-Starting a Car

When jump-starting a car, follow the proper procedures and wear eye protection (Figure 3.35). A battery that



**Figure 3.34** Careless use of the battery charger caused this battery to explode. (Courtesy of Tim Gilles)



**Figure 3.35** Correct connections for jump-starting a car.

has been charging normally (the host vehicle) could have trapped hydrogen gas under its cell caps or the battery terminal clamp. Be sure that no sparks occur near it. Always connect the dead battery last and hook up the ground cable to the engine block away from the battery.

### Battery Acid Safety

Battery acid (**electrolyte**) is a chemical combination of *sulfuric acid* and *water*. Battery acid can harm the skin, eyes, and clothing.

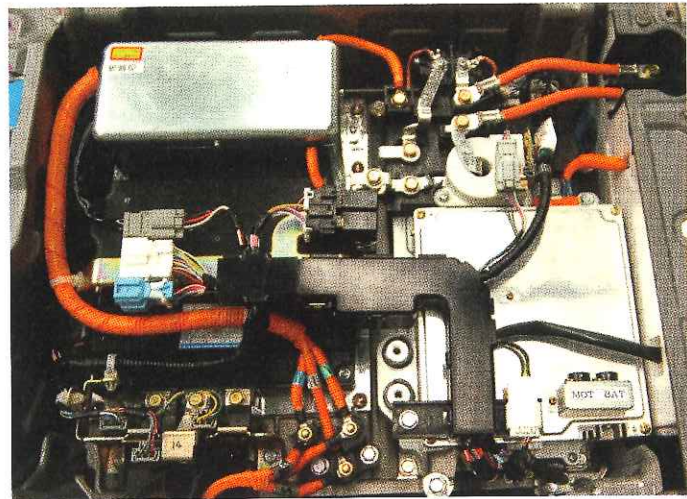
### SAFETY NOTE

If battery acid gets on your skin, immediately wash the area with water for at least 15 minutes.

Baking soda can be used to neutralize battery acid. After carrying or servicing a battery, keep your hands out of your pockets. The outside of a battery is usually covered with acid resulting from the mist from the vent caps during charging. The acid from your hands will cause holes to develop in your pockets after your clothes are washed.

### General Hybrid Safety

If you ever work on a hybrid electrical system, your life will depend on knowing what and when something is safe to touch. Section 6 provides more detailed coverage of hybrid safety. Voltage can range up to 650 volts and 60 amps *instantly*. This can be deadly. All hybrid manufacturers provide ample information on the Internet to allow fire departments and other emergency personnel easy access for training. Toyota emergency information is available at the following Web site: <http://techinfo.toyota.com>



**Figure 3.36** High-voltage cables on hybrid vehicles are orange. Accidental contact can kill you! (Courtesy of American Honda Motor Co., Inc.)

**CAUTION** Orange means high voltage. Do not forget this! Figure 3.36 shows typical orange-colored high-voltage connections in a hybrid vehicle.

**SAFETY NOTE** Liquid refrigerant contained in the air-conditioning system will instantly freeze anything that it comes into contact with.

**REFRIGERANT SAFETY**

Refrigerant is used in automotive air-conditioning systems. It is a vapor at room temperature and becomes liquid only when kept under pressure. When pressure is removed from it (such as when you disconnect one of the air conditioning lines), it boils vigorously as it turns into a vapor.

When working around refrigerants:

- Wear gloves to protect your skin.
- Wear goggles to protect your eyes. Refrigerant can cause instant blindness.

**SCIENCE NOTE**

It is against the law to allow R12 refrigerants found in most 1993 and earlier vehicles to escape into the atmosphere. R12 is a chlorinated fluorocarbon that is believed to damage the ozone layer. (See Chapter 35)

**GENERAL SAFETY AROUND AUTOMOBILES**

Do not leave things on the floor of the shop that people can trip on. Hydraulic service jacks (floor jacks) should be left with the handle up, rather than hanging down low where someone could trip on it. Floor creepers should be stood vertically against a wall or workbench when not in use (Figure 3.37).

**Before a Test Drive**

Before driving a customer's car, remember to check the operation of the brakes and look at the condition of the tires. Do not test drive a car with obvious safety hazards until they are corrected. It makes no sense to test drive a car with dangerous brakes.

**Working Around Belts**

One of the most common farm injuries is lost fingers. Farm machinery has many belts. Fingers are often cut off when they are caught between a belt and pulley.

Be sure that a helper understands what you are asking him or her to do. Assuming that they understand can result in an accident.

Before attempting a fan belt adjustment, be sure that the keys are out of the ignition. If someone cranks the engine over, fingers can be cut off.



**Figure 3.37** Stand a creeper on end when not in use. (Courtesy of Tim Gilles)

**SAFETY TEST**

Choose your answers to the Safety Test from this list:

- |            |              |             |                |             |        |
|------------|--------------|-------------|----------------|-------------|--------|
| 6          | charger      | eye or face | ground         | legs        | talk   |
| 6          | data sheet   | fire        | handle         | manual      | vapor  |
| air        | disconnected | flash       | hydraulic      | orange      | water  |
| asbestos   | drill        | freeze      | hydraulic jack | reground    | water  |
| B          | drilling     | gasoline    | impact         | rest        | water  |
| back, eyes | electrical   | gravity     | instructor     | side        | wrench |
| belt       | end          | green       | jack           | spontaneous |        |
| blowguns   | explosions   | grinders    | jack           | squeezing   |        |

- If you should become injured while working in the shop, inform your \_\_\_\_\_ immediately.
- The most common injuries in an automotive shop involve the \_\_\_\_\_ and \_\_\_\_\_.
- Lift with your \_\_\_\_\_, not your back.
- If a \_\_\_\_\_ is burning out of control, leave the area immediately and call for help.
- A flammable liquid fire is called a Class \_\_\_\_ fire.
- Keep oily materials separated from air to prevent \_\_\_\_\_ combustion.
- What form of gasoline is the most dangerous, liquid or vapor (circle one)?
- Never use \_\_\_\_\_ to clean floors or parts.
- The temperature at which a flammable liquid's vapors will ignite when brought into contact with an open flame is called the \_\_\_\_\_ point.
- Disconnect the battery \_\_\_\_\_ cable before working on a vehicle electric system.
- Before an \_\_\_\_\_ fire can be extinguished, the battery must be disconnected.
- Do not attempt to put out a gasoline fire with \_\_\_\_\_.
- The information sheet about a hazardous material is called a material safety \_\_\_\_\_ (MSDS).
- If caustic Alkaline liquid (from the hot tank) gets into your eyes flush with \_\_\_\_\_, especially under the eyelids.
- A HEPA vacuum is a special vacuum for \_\_\_\_\_.
- The color of the wiring for ground on commercial and household electrical wiring is \_\_\_\_\_.
- Electric cooling fans should be \_\_\_\_\_ before working around them.
- Before opening a radiator, test for pressure in the system by \_\_\_\_\_ the top radiator hose.
- Mushroomed punches or chisels should be \_\_\_\_\_ before use.
- Always wear \_\_\_\_\_ protection when using hammers, chisels, pullers, batteries, air-conditioning machinery, compressed air, and other hazardous situations.
- Always use a \_\_\_\_\_ on the tang of a file.
- Compressed \_\_\_\_\_ can penetrate skin and must be used cautiously.
- Do not \_\_\_\_\_ to someone who is operating a machine.
- A \_\_\_\_\_ bit has a tendency to grab the work when it just begins to break through the metal.
- When \_\_\_\_\_ sheet metal or large pieces of metal on the drill press, make sure they are clamped to the work table.
- Stand to the \_\_\_\_\_ when starting the grinder.
- Position the tool \_\_\_\_\_ as close to the grinding wheel as possible.
- Rubber-tipped \_\_\_\_\_ work at full shop air pressure.
- When using an air impact wrench, be sure to use an extra thick socket, called an \_\_\_\_\_ socket.
- When an air impact \_\_\_\_\_ is used with a wobble socket, the socket can fly off if the tool is started when the socket is not on the bolt head.
- Die \_\_\_\_\_ turn at speeds of up to 20,000 rpm. Be sure to use wheels that are rated for that high a speed.
- Because they can develop force of from 20–50 tons, \_\_\_\_\_ presses can cause parts to explode.
- Locate the correct lift points in the service \_\_\_\_\_ before using a hydraulic service jack or lift.
- When lifting a vehicle on a frame-contact lift, place the lift adapters at the specified locations and raise the vehicle about \_\_\_\_\_". Then, shake it to see that it is firmly placed.

35. Use a \_\_\_\_\_ to raise and lower a vehicle only.
36. A jacked-up vehicle should be placed firmly on \_\_\_\_\_ stands.
37. When moving an engine that is mounted on a shop crane, be sure the engine is lowered as far as possible to keep the center of \_\_\_\_\_ low.
38. Bolts that attach an engine sling or engine stand adapter to the block should enter the block at least \_\_\_\_\_ turns.
39. When using a transmission \_\_\_\_\_ on a car that is on a frame-contact lift, be careful not to raise the car off the lift adapters as you raise the transmission.
40. The most common cause of battery \_\_\_\_\_ is when someone unhooks the battery charger without turning it off.
41. Shut off and unplug the battery \_\_\_\_\_ before unhooking either of the cables.
42. If acid gets on the skin or eyes, immediately flush with \_\_\_\_\_ for at least 15 minutes.
43. If refrigerant from an air conditioning system contacts your skin or eyes it will \_\_\_\_\_ them.
44. The keys should be out of the ignition any time a \_\_\_\_\_ is being inspected or adjusted.
45. When a floor creeper is not in use, it should be stood on \_\_\_\_\_ so it is not accidentally stepped on.
46. Be careful around hybrid vehicle wiring that is colored \_\_\_\_\_.