

# INTRODUCTION TO AUTOMOTIVE TECHNOLOGY

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## UNIT 2: SAFETY

### LESSON 1: PROTECTING YOURSELF AND OTHERS IN THE SHOP

- I. Responsibility for safety
  - A. Safety in the automotive shop is the responsibility of everyone. Safety means protecting yourself and others from injury at all times. Working in the shop requires the use of a large variety of tools, materials, and equipment that can injure the worker and others in the shop if not properly handled.
  - B. Safety in the shop includes the items listed below.
    - 1. Following federal guidelines for safe practices
    - 2. Keeping the shop free of hazards
    - 3. Using protective clothing and equipment
    - 4. Handling and using materials containing potentially harmful chemicals correctly
    - 5. Using hand tools, power tools, and equipment correctly
    - 6. Following welding safety rules
- II. Federal guidelines for safe practices
  - A. Two federal agencies issue guidelines and oversee safety in the workplace.
    - 1. OSHA (Occupational Safety and Health Administration) issues guidelines concerning safety for the worker.
    - 2. The EPA (Environmental Protection Agency) issues guidelines concerning safety for the environment.
  - B. OSHA guidelines and EPA guidelines
    - 1. Each school will have a copy of OSHA and EPA guidelines that must be followed. Due to the changing nature of OSHA and EPA guidelines, the instructor will go over current guidelines with students. All students are required to follow OSHA and EPA guidelines.

2. OSHA guidelines concern the correct labeling of hazardous components of equipment, the correct storage of equipment and materials, the use of protective clothing and equipment, the placement of warning and safety signs, and general safety practices.
3. EPA guidelines concern proper handling, storage, and disposal of hazardous materials. They cover any materials that may be hazardous if released into the environment, including the environment of the shop.
4. See Lesson 4 for more information about these agencies.

### III. General shop safety rules

- A. During the course of working in the shop, an automotive technician moves from one area of the shop to another, moving parts and equipment around the shop and performing varied tasks. It is important that the shop floor be free of hazards that could cause technicians to slip or trip.
- B. In a wide variety of shop tasks, waste materials are produced that can cause dangerous situations unless the waste materials are disposed of or stored properly.
- C. Always be sure that shop exits are well-marked with an “EXIT” sign and are clear of obstructions.
- D. For personal safety and to help keep the shop free of hazards, always comply with the following safety rules.
  1. Work quietly and focus solely on the job at hand.
  2. Do not leave creepers laying on the floor. Always stand them against the wall, wheels outward, when not in use.
  3. Do not indulge in horseplay in the shop. Immature and improper behavior in the shop can cause serious accidents.
  4. Before performing a task, consider the relevant safety precautions related to the task and formulate a prevention plan for each hazard.
  5. Always wear protective clothing and equipment in any situation where it is necessary.

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6. Wear protective eyewear at all times in the shop area.

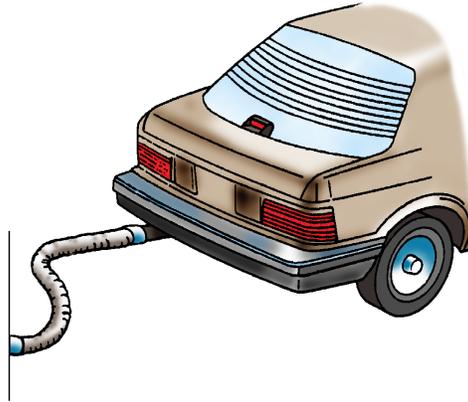


**NOTE:** The law requires that protective eyewear be available and worn in career and technical education courses where there is a reasonable probability of injury.



7. Do not wear rings, bracelets, watches, or necklaces when working around moving machinery or electrical equipment.
- Jewelry can catch in moving machinery with serious consequences.
    - A necklace can become entangled in running machinery, which could pull the technician into the machinery and cause great bodily harm.
    - If a ring or bracelet becomes entangled or caught, it could result in a severed finger or serious injury to the head or neck.
  - If a ring or bracelet should accidentally create a short circuit of a vehicle battery, the metal of the ring or bracelet could become white-hot in an instant, causing a serious burn.
8. Do not put sharp objects into the pockets of work clothes. They could cause personal injury or damage to a vehicle's interior.
9. Keep hands free from oil and grease.
10. Wipe up grease and other spills from the shop floor immediately, or at least put an oil-absorbing compound over them.
11. When cleaning up flammable liquids, always dispose of the rags in a metal container with a tight-fitting lid.

12. Do not look in the direction of another person who is welding.
13. Do not run a vehicle engine inside a closed garage unless the vehicle exhaust is hooked up to exhaust ventilation equipment. A deadly amount of carbon monoxide, which is present in the exhaust, can collect in a very short time.



14. Do not smoke in the shop, except in an area designated for smoking.
15. When pumping a flammable liquid from a large container into a small one, be sure to first attach a ground wire between both containers.
16. Always be alert for hazardous situations in the shop. Promptly correct them, if possible, and inform the instructor of the situation.
17. If road testing a vehicle, always use seat belts, even if only going a short distance.
18. Disconnect the battery as appropriate. This eliminates hazards from shorts that could occur during repair procedures.



**CAUTION: The vehicle manufacturer's recommendations must be followed for disconnecting batteries. Some onboard vehicle computer systems can be damaged if the battery is incorrectly disconnected.**

19. When parts are removed from a vehicle, they should be stored away from the work area (on a bench or, if large parts, against a wall).

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20. Asbestos particles can cause cancer. Asbestos is found in brake shoes and clutches. Therefore, wear a particle mask when doing any cleaning work on brake or clutch parts. Do not use compressed air to clean brake or clutch parts.
21. Do not let the leads on testing equipment fall into the fan of a vehicle while the engine is running. Electric fan motors can turn on even with the ignition off.
22. Do not play with fire extinguishers. Use fire extinguishers only to extinguish fires.
23. Always read the labels on chemicals and materials and follow the instructions.

## IV. General safety rules for handling tools and equipment

- A. Do not operate any piece of equipment unless trained in the use of the equipment.
- B. Even if instructed in the use of a piece of equipment, do not use it unless given specific permission by the instructor.
- C. Select the tool or piece of equipment that will handle the job in the safest and most efficient manner. Use tools or equipment only as recommended by the manufacturer.
- D. Before using a tool or piece of equipment, inspect it for defects, missing or improperly adjusted safety guards, and any other missing or malfunctioning parts.
- E. Maintain and store tools and equipment properly. Develop a regular maintenance schedule for shop equipment. Discard, repair, or replace worn tools because worn tools can be a safety hazard and adversely affect work quality.
- F. Do not use compressed air to blow dirt from clothes and do not point a compressed-air hose at another person.
- G. When using compressed air for cleaning objects in the shop, the air pressure must not be more than 30 pounds per square inch (psi).
- H. Keep tools, especially tool handles, free from oil and grease.
- I. Before using a tool, check the handle to make sure it is secure. For example, a hammer with a loose handle is unsafe because the head may fly off during use.

- J. When operating electric tools, use the proper precautions to avoid electric shock.
- K. Before inspecting or making adjustments to pneumatic or electric tools, always disconnect them from the air or power supply.
- V. Electric welding safety
  - A. Protection from electric shock
    1. Make sure the welder is installed and hooked up properly.
    2. Do not use equipment that is damaged or defective, such as an electrode holder with damaged insulation.
    3. Do not put the electrode holder in water to cool it.
    4. Do not use water to extinguish an electrical fire or any fire near the welder.
    5. Keep the work area, equipment, and clothing dry when using electric welders because even a slight amount of moisture can conduct enough electricity to cause a severe shock.
  - B. Protection from burns and fire
    1. Make sure the work area is as fire resistant as possible.
    2. Do not drag welding cables or hoses through dirt or oil, and do not pull on a cable to force it over an obstruction.
    3. Take precautions when handling hot work pieces. Use tongs or pliers, not hands, to pick up hot metal.
    4. Radiation from a welding arc is strong enough to sunburn or sometimes blister bare skin if the exposure is intense or for an extended period, so the arms, legs, and torso should be covered with durable, flame-resistant clothing.
    5. Keep the work area clean and free of trash, grease, oil, and other flammable materials.
    6. Keep a fire extinguisher, first-aid kit, and safety equipment within easy reach.
    7. Do not drape an electric welding cable over any type of gas cylinder, and do not strike an arc on a gas cylinder.

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## C. Protection from arc rays

1. A welding arc produces ultraviolet and infrared radiation that can severely burn eyes that are unprotected with a proper shade of protective lens.

**NOTE:** A welding hood or helmet protects the head from flying sparks and the shaded lens protects the eyes.



2. Make sure all others in the welding area are wearing eye protection as well.
3. When using a welder, enclose the welding area to protect others from the dangers of arc rays.

## D. Protection from toxic fumes and vapors

1. Many welding activities produce toxic fumes and vapors that are hazardous to breathe, and every work station should be equipped with a ventilation or exhaust system capable of safely removing dangerous and irritating smoke and contaminants.

**CAUTION:** Always position the head to the side of rising fumes.

2. In confined areas where the hazard of toxic fumes is increased, a welder should wear an air-supplied respirator or a self-contained breathing apparatus, not a filter-type mask that cannot compensate for oxygen displacement.
3. Clean the metal before welding. Cleaning the metal helps remove any chemical that might mix with the fumes produced by welding.



## VI. Oxyacetylene welding and cutting safety

### A. Protection from burns (from heat or light rays), fire, and explosions

1. Do not allow oil or grease to come in contact with oxygen under pressure.



**NOTE:** No lubrication of the apparatus is necessary.

2. Do not use oxygen as a substitute for compressed air.
3. Before starting to weld or cut, make certain there is no flammable material nearby.
4. Always wear welding goggles and heavy gloves when working with a lighted torch.
5. Wear welding goggles and protective clothing that blocks harmful light from the acetylene flame.
6. When using a welder, enclose the welding area to protect others from the dangers of acetylene flames.
7. Do not use matches for lighting acetylene torches. A spark lighter, held at an angle, should be used to light a torch.
8. Do not relight oxyacetylene flames on a hot work section in a small confined space.

**CAUTION: Acetylene gas gathers in one spot.**

9. Do not use acetylene at a pressure above 15 psi.

**CAUTION: Using acetylene at a pressure above 15 psi may result in hand burns.**

10. Use particular caution when welding or cutting in dusty or dirty locations.

**CAUTION: Dust can explode.**

B. Protection from toxic fumes and vapors

1. Many welding or cutting activities produce toxic fumes and vapors that are hazardous to breathe, and every work station should be equipped with a ventilation or exhaust system capable of safely removing dangerous and irritating smoke and contaminants.

**CAUTION: Always position the head to the side of rising fumes.**



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2. In confined areas where the hazard of toxic fumes is increased, a welder should wear an air-supplied respirator or a self-contained breathing apparatus, not a filter-type mask that cannot compensate for oxygen displacement.

**CAUTION: Argon is much heavier than air and quickly displaces oxygen, so be especially careful using the MIG process in a confined area, even though the area appears to have adequate ventilation.**

3. Clean the metal before welding or cutting. Cleaning the metal helps remove any chemical that might mix with the fumes produced by the process.
4. Some of the materials that give off especially toxic fumes are brass, bronze, galvanized materials, iron or steel coated with lead, or paint containing lead.

### C. Safe handling of gas cylinders

**CAUTION: The acetylene and oxygen cylinders are highly pressurized and may explode if not handled properly.**

1. Oxygen and acetylene cylinders must be stored in a ventilated area and must be kept separate. Allow at least 20 ft between oxygen cylinders and acetylene cylinders.
2. All gas cylinders must be secured in both the storage area and on the wheeled cart with a safety chain or approved lashing.
3. The protective caps must be in place any time the cylinders are not in use.
4. Do not move the cylinders without protective caps in place.
5. Do not drop or knock cylinders around.
6. Do not tamper with safety devices or markings on a cylinder.
7. Do not use a hammer or wrench to open a cylinder valve.
8. Do not move a cylinder unless confident in handling it.



9. Always move a gas cylinder by using a hand truck with a safety chain or by tilting it slightly and rolling it on its bottom edge with one hand on the protective cap.



**CAUTION:** Do not tilt the cylinder too far over center; it may cause the cylinder to drop.

### VII. Lifting safety

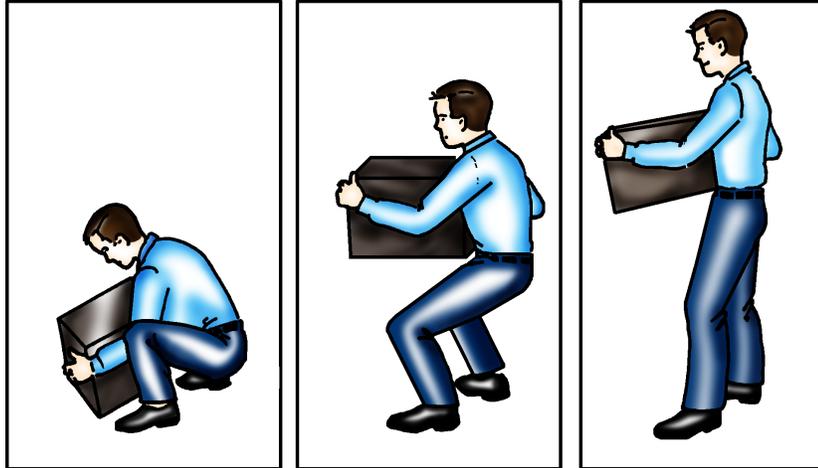
- A. The technician will encounter many situations in which heavy objects must be lifted from the floor. Back injuries are common if lifting is not done properly.
- B. Alternatives to lifting heavy objects
  1. Avoid lifting, if possible.
  2. Move heavy objects by pushing, pulling, rolling, or sliding.
  3. Use hoists, jacks, carts, and wheel trucks when possible.
- C. To avoid injury when lifting a heavy object, use a mechanical device or get the assistance of another person.

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### D. Steps of procedure to lift an object

**CAUTION:** Do not lift in an area where the floor is wet or greasy.



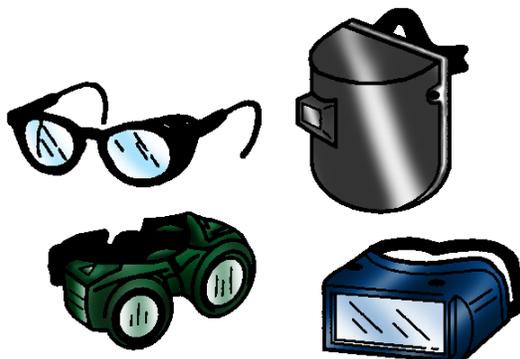
1. Spread the feet slightly, until comfortable, with one foot slightly ahead of the other and along side of the object.
2. Bend the knees, kneel, or squat; do not bend the back.
3. Use blocking under objects to get a hand hold.
4. Get a good grip and use gloves if the object has sharp or jagged surfaces.
5. Lift with the leg, arm, and shoulder muscles, straightening the legs and coming to a standing position.
6. Shift the feet to turn; do not twist.
7. Lower the load by bending the knees, keeping the back straight and using leg and arm muscles, and keep fingers and toes clear of objects.
8. Use blocking to keep from pinching the fingers when setting the object down.

### VIII. Personal protective clothing and equipment

**CAUTION:** Personal protective clothing and equipment should not be considered the first line of defense against injury but rather as backup protection.



- A. Wear protective eyewear at all times in the shop area.



**NOTE:** The law requires that protective eyewear be available and worn in career and technical education courses where there is a reasonable probability of injury.

1. Special splash-resistant goggles are worn when there is a potential chemical hazard.



2. When welding, a welding hood or helmet must be worn to protect the head from flying sparks and protect the eyes from burns.
3. Tinted goggles may be required if welding is being performed close to the work area. Consult the instructor for the appropriate tinted goggles for the welding operation.
4. Proper glasses and wire mesh goggles or plastic spectacles with side shields are required in impact hazard areas, such as grinding areas.
5. Every person, including visitors, must wear industrial-quality protective eyewear at all times in the shop area.

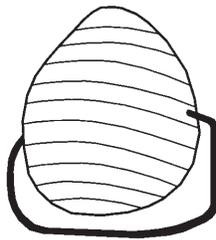
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- B. Wear a full face shield in situations where sharp flying objects could injure the face.



- C. Respiratory protection is sometimes necessary. Respiratory devices consist of a mesh that covers the nose and mouth. Wear a respiratory mask when doing tasks that can create dust.



- D. Noise in the shop can cause hearing damage, depending on the level and duration. Wearing ear plugs and ear muffs helps protect the ears from noise created by equipment such as pneumatic tools, grinders, and engines.



- E. Adequate footwear should be worn in the shop area. Feet can easily be crushed, cut, or punctured if not properly protected.

1. Footwear should have leather or rubber oil-resistant soles.
2. Footwear should provide a full leather or strong fabric cover for the entire foot up to the ankles.

**NOTE:** Footwear with steel-reinforced toes provides even more protection.

3. High-top leather boots are recommended for welding operations.





- F. Protective clothing for the body and hands reduces the hazard of injury and protects street clothing.
1. Gloves and hand leathers are important pieces of protective clothing. Different tasks require different materials (e.g., rubber gloves are worn when handling caustic chemicals and heavy leather gloves with gauntlets are worn when welding).

**CAUTION: If operating machinery and wearing gloves, the gloves may become entangled in the moving parts.**

2. Aprons are used to protect from sparks, hot metal splashes, and splashing liquids. The material should be suitable for the intended use.

**CAUTION: Never wear loose aprons around revolving or reciprocating machinery.**

3. Coveralls protect the body. Overalls, a variation of coveralls, do not have sleeves. Fire-resistant coveralls made of cotton or wool are recommended for welding operations.
4. Shop coats provide protection against dirt and grease that soil street clothing. These also offer some protection against chemicals and hot substances.

IX. The importance of proper grooming and hygiene

- A. Long hair can become caught in moving machinery, which can result in a portion of scalp being lost or pulled into the machinery. Keep long hair out of machinery by pinning it up or wearing a cap.
- B. Jewelry should not be worn in the shop. See section III in this lesson for the specific hazards related to jewelry.
- C. Having greasy hands can cause slippage when working with hand tools. Grease also soils interiors and paint.
- D. Having grease on work shoes can spread grease across the shop floor, which increases the risk of slipping and falling. Dirty, greasy coveralls/overalls and shoes can ruin vehicle interiors.
- E. Having brake fluid and other chemicals on the hands could allow accidental transfer to painted surfaces and cause expensive repairs.

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F. Protective eyewear that is dirty and scratched is difficult to see through. Protective eyewear should be kept clean. Do not place the lenses down on the floor or table. The soft, plastic coating can easily be scratched.

X. Hazardous materials safety

A. Five general safety rules

**CAUTION: Consult the instructor before using an unfamiliar product.**

1. Follow the manufacturer's recommendations. Refer to material safety data sheets (MSDSs). See Lesson 4 for information about MSDSs.
2. Carefully read the product label for correct uses and hazards.
3. Be careful to prevent spills, damage to the vehicle, or unsafe situations/conditions.
4. Properly store chemicals and used rags.
5. Use chemicals only for their intended purposes.

B. Hazardous materials include the following:

**NOTE:** The following list includes some of the more common chemicals found in the shop and is not meant to be all-inclusive. See Unit 3 for the safety precautions and uses of these chemicals.

1. Solvents and acids – Part-washing solvents, choke and carburetor cleaner, brake cleaner, gasket remover, digestive-type carburetor cleaner, and vehicle battery acid
2. Lubricants – Rust-penetrating oil, silicone lubricant, liquid graphite, motor oil, automatic transmission fluid, power steering fluid, gear lube, hydraulic fluids, various greases, and specialty additives (e.g., oil treatment and gas treatment)
3. Gases and dust – Gases in engine exhaust, vapors from gasoline, refrigerant gas, and asbestos dust from brake and clutch linings



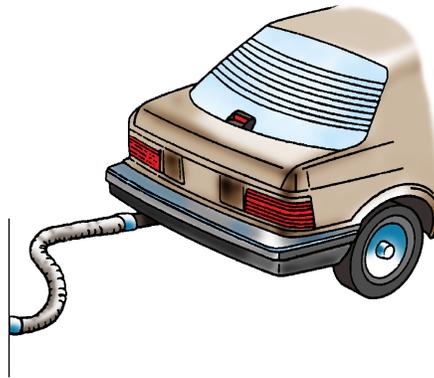
C. Safety from skin damage and fire

1. Many chemicals in the shop pose a hazard to the skin and eyes. Follow the safety precautions on the product label.
2. Keep electrical devices, sparks, and any hot material away from flammable chemicals.

D. Safety from toxic fumes

**CAUTION: Breathing toxic fumes can cause dizziness, nausea, headaches, unconsciousness, and can even lead to death.**

1. A common source of toxic fumes in the shop is the exhaust from a running engine. Each time a vehicle's engine is run in the shop, exhaust ventilation equipment should be attached to the vehicle to properly vent the carbon monoxide, a poisonous gas emitted in the exhaust.



**CAUTION: Be sure to use approved exhaust ventilation equipment when operating a vehicle in an enclosed area.**

2. Whenever fumes or vapors are present, be sure to turn on the shop's ventilation system as soon as possible to remove them.

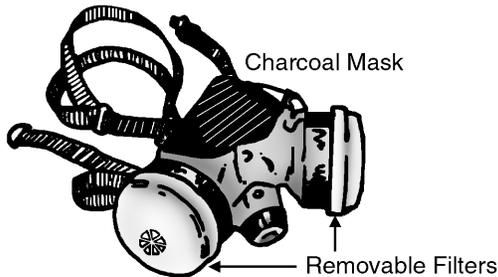


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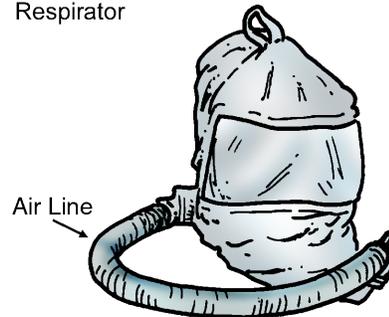
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3. Use breathing protection, such as a respirator, when working with any materials or chemicals that could be hazardous if inhaled.

Respirator With  
Removable Filters



Air-Supplied  
Respirator



### XI. Safety precautions for supplemental restraint systems (SRSs) and antilock brake systems (ABSs)

**NOTE:** Technicians need to be aware of special safety considerations when working on or around these systems.

#### A. SRS or air bag system

1. First appearing in a few 1985-model vehicles, air bag systems are standard equipment on most vehicles on the road today. A ruling by the National Highway Traffic Safety Administration required all new passenger cars to have dual air bags (one on the driver's side and one on the passenger's side) by 1998 and all new light trucks to have dual air bags by 1999.
2. The SRS is designed to inflate when a vehicle collides head-on with an object at a speed of more than 14 mph. During the collision, the driver and passenger impact the air bag rather than the steering column or dashboard.
3. In addition to driver-side and passenger-side air bags, some vehicles may be equipped with side-impact, window, and rear-seat air bags.
4. Air bags are relatively new devices. New safety issues regarding air bags are continually being recognized and studied.
5. Air bags must be used with seat belts, shoulder harnesses, and the proper headrests to provide maximum protection.





**NOTE:** It is important for everyone in the automotive industry, including automotive technicians, to explain to the public that the SRS alone does not provide maximum protection in a collision.



6. Before working near a vehicle's air bags, be sure they are disabled.

**CAUTION:** The force of an air bag can break bones and cause other serious injuries.

7. Even if an air bag has been disabled, the air bag may deploy if the diagnostic module's reserve power has not been depleted.



**CAUTION:** The diagnostic module keeps the air bag activated for some time after the negative battery cable has been disconnected. Wait until the diagnostic module's reserve power has depleted before working on or around the SRS. The time can vary from a few seconds to over 30 minutes.

### B. ABS

1. An ABS helps the driver maintain control of the vehicle when braking. If the wheels lock during braking, the vehicle may slide out of control. The antilock system prevents the brakes from being applied hard enough to lock the wheels.
2. Even when the antilock system closes down, normal power-assisted braking remains. A warning light located in the instrument panel indicates problems.
3. Listed below are general precautions to observe when servicing the ABS.



**CAUTION:** Failure to observe these precautions may result in personal injury and damage to the ABS.

- a. Follow the service information carefully. Use the proper service information for the vehicle. Using the wrong sequence of service steps, skipping steps, or using the wrong information leads to unnecessary replacement of parts.
- b. Some brake parts contain asbestos fibers that can become airborne as dust during brake service. Follow the latest federal procedures when working with asbestos.

**CAUTION: Asbestos is a cancer-causing substance. Do not breathe asbestos dust or allow it to escape into the air.**



- c. Many components of an ABS are not serviceable; replace them as an assembly. Disassembling an ABS component that is not designed to be serviced may cause personal injury or system malfunction.
  - d. There is no one bleeding procedure that applies to all ABSs. Procedures vary greatly from system to system. To bleed a vehicle with an ABS, use the manufacturer's specific bleeding method for the vehicle being serviced.
  - e. If using electric arc welding equipment on a vehicle with an ABS, disconnect the battery and powertrain control module (PCM).
  - f. An ABS operates at very high pressures. Always depressurize the accumulator before servicing the ABS.
  - g. To protect the control module, never disconnect or connect any ABS connector while the ignition switch is on.
  - h. Portions of an ABS operate at very low system voltages; therefore, never use a conventional 12-volt test light to probe circuits. A conventional 12-volt test light can damage the antilock components. Always use a high-impedance digital multimeter (DMM) to probe the circuits.
  - i. When working with wiring on an ABS, never touch the electrical connections or pins or allow them to contact the brake fluid. This kind of contact damages the PCM.
  - j. Before test driving a vehicle with a brake problem, test the brakes at a low speed to be sure that the car stops normally.
- C. Procedures for identifying vehicles equipped with an SRS and ABS
- 1. On some vehicles, the vehicle identification number (VIN) indicates that the vehicle is equipped with an SRS and ABS. Check the manufacturer's service information to determine what digits indicate that the vehicle is equipped with an SRS and ABS.

2. The schematics may also come with various warnings that the vehicle is equipped with an SRS and ABS.
3. Some vehicles have a mark on the steering wheel cover to indicate an SRS.