Chapter 5
Shop Safety

After studying this chapter, you will be able to:
- List common types of accidents.
- Identify fire hazards.
- Explain how an electrical fire can start.
- Identify asphyxiation hazards.
- List safety rules.
- Explain what qualifies a material as a hazardous waste.
- Describe the regulations concerning the disposal of hazardous wastes.
- Explain the importance of material safety data sheets.

Know These Terms

- Asphyxiation
- Ignitable hazard
- Corrosive hazard
- Material safety data sheet (MSDS)
- Electrical fires
- Reactivity hazard
- Explosion
- Respirators
- Fire
- Toxicity hazard
- Gasoline
- Hazardous waste
Hundreds of engine technicians are injured or killed each year while on the job. A majority of these incidents resulted from broken safety rules, Figure 5-1. As an engine technician, you will be exposed to many potentially dangerous situations. You will be working around running engines, engines suspended in the air on a hoist, gasoline, and numerous other possible hazards. Moving vehicles in the close quarters of a service facility can also be hazardous. You must learn to control these dangerous situations and keep your job safe and enjoyable. This chapter reviews basic shop safety and will help you gain basic safety skills.

Types of Accidents

There are six common types of accidents—fires, explosions, asphyxiation, chemical burns, electric shock, and physical injuries. To create a safe working environment, you must prevent these. Each could cripple or kill you or someone else.

Fires

A fire can cause horrible destruction, injury, and death. Fire is the result of heat, fuel, and oxygen in the correct proportions to start combustion. When working on engines, gasoline, diesel fuel, cleaning solvents, and oily rags are just a few of the many possible sources of fuel in a service facility. Fire extinguishers are rated in terms of the type of fire for which they should be used. See Figure 5-2.

Gasoline is the most dangerous flammable in the shop, Figure 5-3. Just a cup of ignited gasoline can engulf a whole engine compartment in flames. The fire may then consume the rest of the vehicle and maybe the entire shop.

A few rules for handling gasoline include:

- Never use gasoline as a cleaning agent. Cleaning solvents are flammable, but not as flammable as gasoline.
- Keep sources of heat, such as welding and cutting equipment, away from the engine's fuel system.
- Wipe up gasoline spills right away. Do not spread oil absorbent (oil-dry) on a gasoline spill because the absorbent will become flammable.
- Disconnect the car battery before working on the fuel system.
- Wrap a shop towel around any fitting when disconnecting a fuel line. This will collect fuel that leaks or sprays out.
- Store gasoline and other flammables in approved, sealed containers.

A burning engine can be dangerous. Hot parts can cause burns. Spinning fans can cause deep cuts. Exhaust fumes can cause asphyxiation.

Explosions

An explosion is a violent expansion of gases due to rapid combustion. There are several possible sources of explosion when servicing an engine or its systems. For example, a vehicle's battery can explode. The chemical reaction that takes place inside the battery to produce electricity also generates hydrogen gas. As shown in Figure 5-5, this highly explosive gas can surround the top of the battery. The slightest spark or flame can ignite the gas and cause the battery to explode. Fragments of battery case and the battery acid can travel through the air as the result of the explosion. Blindness, cuts, acid burns, and scars can result.

Various other sources can result in explosions. For example, sodium-filled engine valves, welding tanks, propane bottles, and fuel tanks can all explode if mishandled. These hazards are discussed in later chapters where appropriate.

Asphyxiation

Asphyxiation is a condition in the body in which the body has too little oxygen or too much carbon dioxide. It may be caused by breathing toxic or poisons substances in the air. Mild cases of asphyxiation will cause dizziness, headaches, and vomiting. Severe asphyxiation can cause death.

The most likely source of asphyxiation in a service facility is the exhaust gases from the vehicle's engine. Exhaust contains very little oxygen. Coupled with the fact that the engine is consuming oxygen for combustion, the oxygen in an enclosed shop can quickly be depleted. In addition, an engine's exhaust gases contain carbon monoxide, which is deadly poison. Using an exhaust hose, connect the vehicle's tailpipe to the shop's exhaust ventilation system, Figure 5-6.

Also, make sure the exhaust ventilation system is turned on whenever the engine is running. There are other substances in the shop that are harmful if inhaled. One of these harmful substances is asbestos, which may be found in the dust from a clutch disc or older brake pads. Respirators (filter masks) should be worn when working around any kind of airborne impurities, Figure 5-7. If welding during major engine repair or in a machine shop, a special welding respirator should be worn. It will trap toxic welding fumes and block them from entering your nose, mouth, throat, and lungs.

Warning: A filter mask or respirator will only protect you from the substances for which it is rated. A dust mask will not protect against toxic fumes.
Chemical Burns

Various solvents, battery acid, and a few other substances found in the shop can cause chemical burns to the skin. Decarbonizing cleaner (“carb cleaner”), for example, is powerful and can severely burn your skin in a matter of seconds. Always read the directions and warnings on chemicals. See Figure 5-8.

Wear rubber gloves and eye protection. If a skin burn occurs, follow the treatment directions on the product label.

Electric Shock

Electric shock can occur when using improperly grounded electric power tools. Never use an electric tool unless it has a functional ground prong. This is the third, round prong on the plug. The ground prong prevents current from accidentally passing through your body. Also, never use an electric tool on a wet shop floor.

Warning: Use extreme caution when working with hybrid vehicles. They operate at voltages as high as 600 volts AC. This is enough electricity to kill.

Physical Injury

Physical injuries, such as cuts, broken bones, and strained backs, can result from hundreds of different accidents. As an engine technician, you must constantly think and evaluate every repair technique. Decide whether a particular operation is safe or dangerous and take action as required. For example, why move an engine block by hand when a crane is available? You and a friend may be strong enough to lift the engine block, but why risk back injury? Once your back is injured, it will never be the same!

General Safety Rules

The following list provides several general safety rules. Remember these and follow them at all times.

- Wear appropriate eye protection during any operation that could endanger your eyes! See Figure 5-9. This includes operating power tools, working around a

Figure 5-3. Gasoline is the most dangerous and underestimated flammable. A cup of gasoline, when ignited, can engulf a vehicle in flames.

Figure 5-4. Electrical fire can occur when a wire shorts to ground. The resulting high current causes enough heat to make the wire insulation burn. Always disconnect the battery before working on wiring.

Figure 5-5. A battery can explode, caused by a spark igniting the hydrogen gas that can collect around the top of the battery.

Figure 5-6. Use an exhaust ventilation system when running an engine in an enclosed area.

Figure 5-7. When working around airborne toxins, wear an approved respirator. It will help keep harmful chemicals out of your lungs.

Figure 5-8. Battery acid can cause severe chemical burns. Make sure you read and follow label directions on caustic products. Note the treatments (antidotes).

Figure 5-9. Wear appropriate eye protection. There are several types available for different situations.
Keep your shop organized. Return all tools and equipment to their proper storage areas. Never lay tools or parts on the floor. Figure 5-10.

- Keep your shop organized. Return all tools and equipment to their proper storage areas. Never lay tools or parts on the floor. Figure 5-10.
- Dress like a professional technician. Remove rings, bracelets, necklaces, watches, and other jewelry. They can get caught in engine fans, belts, etc., causing injury. Also, roll up long sleeves and secure long hair. They, too, can get caught in spinning parts.
- Work like a professional. When learning to be an engine technician, it is easy to get excited about your work. However, avoid working too fast. You could overlook a repair procedure or safety rule and cause an accident.
- Use the right tool for the job. There is usually a tool that is best suited for each repair task. Always ask yourself this question: Is there another tool that will work better?
- Never carry sharp tools or parts in your pockets. They can easily puncture your skin.
- Keep equipment guards or shields in place. If a power tool has a safety guard, use it. Refer to Figure 5-11.
- Lift heavy parts with your legs, not with your back. When lifting, bend at your knees while keeping your back as straight as possible. On extremely heavy assemblies, such as transmissions, engine blocks, and transaxles, use a portable crane.
- Use adequate lighting. A portable shop light increases safety, work speed, and precision.
- Ventilate your work area when needed. Turn on the shop ventilation fan or open the shop doors anytime fumes are present in the shop.
- Never stir up asbestos dust. Asbestos is a cancer-causing agent. Do not use compressed air to blow the dust off brake parts or clutch assemblies.
- Jack up or raise a vehicle slowly and safely. Figure 5-12. A car or light truck may weigh as much as two tons.

- Never work under a vehicle unless it is supported by jack stands. Figure 5-13. It is not safe to work under a vehicle held up by only a floor jack. Also, chock (block) the vehicle's wheels when the car is on jack stands.
- Drive slowly when in the shop area. With students and vehicles in the shop, it is very easy to have an accident.
- Keep away from spinning engine fans. The engine fan is like a spinning knife. It can inflict serious injuries. Also, if a part or tool is dropped into the fan, it can fly out and hit someone or damage the radiator.
- Respect running engines. When an engine is running, make sure that the transmission or transaxle is in park. Check that the emergency brake is set and that the wheels are blocked.
- Do not smoke in the shop. Smoking is a serious fire hazard considering fuel, cleaning solvents, and other flammables that are in the shop.
- Chemical pneumonia can result from inhaling oil mist. Dermatitis can result from skin contact with oil.
- Obtain permission before using any new or unfamiliar power tool, lift, or shop equipment. Your instructor will need to provide training on proper use. See Figure 5-14.
- Wear ear protection when using loud power tools. For example, if you are using an air chisel to cut off an old exhaust system, the sound generated by the hammer action can be above a safe limit. To avoid partial loss of your hearing, wear earplugs or earmuffs, as shown in Figure 5-15.
- Wear gloves when needed while working. Leather gloves will protect your hands from cuts and abrasions. Latex or rubber gloves can be used to protect your skin from oil and grease.
- Use compressed air with caution. Air lines can contain up to 150 psi (1000 kPa) of air pressure. If air is forced through your skin and into the bloodstream, death can result. Never direct a blow nozzle at you or anyone else.
- Keep equipment guards or shields in place. If a power tool has a safety guard, use it. Refer to Figure 5-11.
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- Jack up or raise a vehicle slowly and safely. Figure 5-12. A car or light truck may weigh as much as two tons.

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Used parts cleaners and degreasers. These are commonly found in auto shops and can be hazardous. Safety precautions should be followed when using them.

Other discarded lubricants, such as transmission and differential fluids, can also be hazardous.

Used motor oil. It is combustible and may contain toxic chemicals.

Decarbonizing cleaners. These contain flammable or combustible liquids.

Disposing of Shop Wastes

Automotive service and maintenance facilities frequently generate hazardous wastes. These wastes are regulated by the Resource Conservation and Recovery Act. This federal act applies to businesses that generate, transport, or manage hazardous wastes. Any business that maintains or repairs vehicles, heavy equipment, or farm equipment must comply with the regulations of the act.

Hazardous Waste

Hazardous waste is a solid, liquid, or gas that can harm people or the environment. There are several criteria for determining if a substance is hazardous. A substance is considered a hazardous waste if it will easily ignite and burn. Gasoline, diesel oil, solvents, and other chemicals are considered ignitable hazards.

A material or waste is a corrosive hazard if it dissolves metals and other materials or burns human skin. Battery acid and many part-cleaning solvents are considered corrosive hazards.

Anything that reacts violently or releases poisonous gases when in contact with other materials is considered a reactive hazard. Materials that generate toxic mists, fumes, vapors, and flammable gases are also reactive hazards.

Materials like lead, cadmium, chromium, arsenic, and other heavy metals that can pollute water and soil are considered toxic hazards.

The refrigerant in the air conditioning systems must not be vented to the atmosphere. Regulations require that they be recovered and recycled. Several types of refrigerant-recovery systems are available.

Antifreeze

Antifreeze is classified as a hazardous waste due to its heavy metal and chlorinated solvents that it picks up when circulating through an engine's cooling system. In addition, antifreeze presents several health hazards. See Figure 5-18. Used antifreeze should never be mixed with used oil. In addition, it must be collected and disposed of by a registered hazardous waste recycling/disposal company.

Refrigerant

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Disposal

One of the best ways to deal with hazardous wastes is to minimize the quantity produced. This can be accomplished by practicing good housekeeping, improving inventory control, and following proper spill-containment techniques.

When hazardous wastes are produced, they must be disposed of properly. Regulations require that these wastes be collected by a registered hazardous waste hauler. Several major companies offer pick up and recycling services. Repair or maintenance facilities that generate 220 lb (100 kg) of hazardous waste monthly must fill out a Uniform Hazardous Waste Manifest before shipping the wastes to a disposal or recycling site. The manifest is a tracking document that must accompany hazardous wastes when they are shipped from the work facility. It contains detailed information about the origin, character, and destination of the wastes. When shipping certain wastes, the proper Department of Transportation (DOT) shipping descriptions must be listed on the manifest. Tables listing these descriptions are available from your state's hazardous waste management agency or from a regional EPA office.

EPA regulations state that no manifest is needed for used oil or lead-acid batteries sent off for recycling. In such cases, the material is not regarded as hazardous. Your state might have its own requirements. Check with your state hazardous waste management agency.

Used oil filters are considered hazardous waste unless they are to be recycled for scrap metal. If not recycled, they must be listed on the manifest as hazardous. Before disposal, oil filters should be gravity drained so that they do not contain free-flowing oil. Then, store them in a closed, labeled container for pickup by a recycler.

Material Safety Data Sheets

Always read label directions when using chemicals. Rust penetrant, lubricants, part cleaners, and other substances can be dangerous if not used properly. The product label will give general precautions for using the product.

Chemical manufacturers are required to provide a material safety data sheet (MSDS) for each chemical that they produce. This sheet is important because it lists all of the known dangers and treatment procedures for a specific chemical. Employers are required to have an MSDS for each chemical or substance used in their facility. Be sure to read the MSDS for any chemical or substance that you are not familiar with.

Hybrid Service Safety

A hybrid vehicle uses a gasoline engine, a powerful electric motor, and a battery pack to propel the vehicle. Hybrid vehicles have specific safety recommendations that
Hybrid Voltage

Modern gas-electric hybrid drive systems have enough electrical energy to cause electrocution. Most hybrids conduct 3-phase AC at almost 600 volts and almost 300 volts DC at hundreds of amps. By comparison, the voltage at a home wall outlet is 120 volts AC. Yet many people are killed or injured each year by this voltage. The 240 AC led into a repair shop operates high-power equipment (air compressors, central air conditioning, furnaces, vehicle lifts, etc.). If shorted to ground, 240 volts causes a powerful electric arc. Since hybrids operate at even higher voltage levels, it is important to respect the potential for electric shock.

Disabling Hybrid Drive

A hot hybrid system is one in which high and low voltage are potentially present in the electric drive system. You cannot turn off the power inside the battery pack, but you can disconnect it from the rest of the drive system. To disable a gas-electric hybrid for repair, turn the ignition key off. This will cause the hybrid ECU to de-energize the relays or contactors that connect the battery pack to the motor-generator. Some automakers also require disconnection of the conventional 12V battery, to prevent accidental energizing of the high-voltage circuits.

System de-energization is important because a hybrid’s drive train can be engaged and ready to accelerate even without the gas engine running. If the key is in the on position, the vehicle can accelerate and drive forward or backward if the gas pedal is pressed accidentally. Such movement could result in personal injury and property damage.

High-Voltage Disconnect

Each high-voltage disconnect provides on gas/electric hybrids disconnects the battery pack from the power control module. On some hybrids, the disconnect is pulled out to produce an open circuit between the battery pack and the power control module. With other designs, the disconnect has a switch that is rotated to provide an open in the battery pack circuit.

Hybrid high-voltage disconnects are usually located near the battery pack in the trunk, under the seat, on the side of a seat under a trim panel, or other similar location.

Summary

A service facility can be a safe and enjoyable place to work if safety rules are followed. However, if safety regulations are not followed, the shop can be a very dangerous place to work. Always make sure you are using approved, safe practices when working on a vehicle. You must prevent fires, explosions, chemical burns, electric shocks, and other physical injuries. Constantly think about what you are doing and take corrective action when needed.

Automobile service facilities can be hazardous places to work. The shop can be a very dangerous place to work. Always make sure you are using approved, safe practices when working on a vehicle. You must prevent fires, explosions, chemical burns, electric shocks, and other physical injuries. Constantly think about what you are doing and take corrective action when needed.

Hybrid high-voltage disconnects are usually located near the battery pack in the trunk, under the seat, on the side of the rear seat, under a piece of plastic trim.
Review Questions—Chapter 5

Please do not write in this text. Write your answers on a separate sheet of paper.

1. List six common types of accidents.
2. _____ is the most dangerous flammable in the shop.
3. Which of the following is not an acceptable cleaning agent?
   (A) Decarbonizing cleaner.
   (B) Gasoline.
   (C) Soap.
   (D) Degreasing solvent.
4. What should you do when disconnecting an engine fuel line to prevent fuel from spaying out?
5. How can a short cause an electrical fire?
6. Batteries generate _____, which can explode.
7. Why is engine exhaust dangerous?
8. Why is a ground prong provided on electrical equipment?
9. Why should you remove jewelry when on the job?
10. Why must the drive wheel engaged to the motor-generator be raised off the ground while towing?
11. In a _____ hybrid system, high and low voltage are potentially present in the electric drive system.

ASE-Type Questions—Chapter 5

1. Technician A says that you should disconnect the battery before removing a fuel line from an engine. Technician B says that you should wrap a shop towel around the fitting before disconnecting a fuel line. Who is correct?
   (A) A only.
   (B) B only.
   (C) Both A and B.
   (D) Neither A nor B.
2. Technician A says that a fire extinguisher bearing this symbol can be used on burning oil or gasoline. Technician B says that a fire extinguisher bearing this symbol can be used on an electrical fire. Who is correct?
   (A) A only.
   (B) B only.
   (C) Both A and B.
   (D) Neither A nor B.
3. The most likely source of asphyxiation in an auto shop is _____.
   (A) gasoline
   (B) oily shop rags
   (C) engine exhaust
   (D) None of the above.
4. Technician A says that a battery can produce gases that can cause an explosion. Technician B says that sodium-filled engine valves, if mishandled, can cause an explosion. Who is correct?
   (A) A only.
   (B) B only.
   (C) Both A and B.
   (D) Neither A nor B.
5. Technician A says that a respirator will block all poisonous fumes that can be produced in a shop. Technician B says that a respirator will block only those fumes for which it is rated. Who is correct?
   (A) A only.
   (B) B only.
   (C) Both A and B.
   (D) Neither A nor B.
6. Technician A says that battery acid can cause chemical burns to the skin. Technician B says that some decarbonizing cleaners can cause chemical burns to the skin. Who is correct?
   (A) A only.
   (B) B only.
   (C) Both A and B.
   (D) Neither A nor B.
7. Technician A says that an electric power tool with a faulty ground prong can cause electrocution. Technician B says that if a power tool’s faulty ground prong is removed, the power tool is safe to use. Who is correct?
   (A) A only.
   (B) B only.
   (C) Both A and B.
   (D) Neither A nor B.
8. Technician A says that eye protection should be worn when carrying a battery. Technician B says that eye protection should be worn when working around an engine fan. Who is correct?
   (A) A only.
   (B) B only.
   (C) Both A and B.
   (D) Neither A nor B.
9. Technician A says that used batteries are considered a hazardous waste. Technician B says that used decarbonizing cleaner is considered a hazardous waste. Who is correct?
   (A) A only.
   (B) B only.
   (C) Both A and B.
   (D) Neither A nor B.
10. All of the following are safety rules to follow when working in an auto shop except:
    (A) never carry sharp parts or tools in your pocket.
    (B) always lift heavy engine parts with your back, not with your legs.
    (C) keep the auto shop organized.
    (D) always keep equipment guards or shields in place.
11. Technician A says that refrigerants can be vented into the atmosphere as long as proper filtering systems are utilized. Technician B says that used motor oil should be recycled. Who is correct?
    (A) A only.
    (B) B only.
    (C) Both A and B.
    (D) Neither A nor B.