MLR: Service and Safety

Table of Contents

Unit 1: Automotive Technology Careers

Chapter 1: Careers

Opportunities in the Automotive Field

According to statistics from the U.S. Department of Labor, over 800,000 people in the United States are employed as automotive service technicians and mechanics. Most are employed in:

- Automotive repair and maintenance shops
- Automobile dealers
- Retailers and wholesalers of automotive parts, accessories, and supplies

Others work in the following businesses or organizations:

- Gas stations
- Home and automotive supply stores
- Automotive equipment rental and leasing companies
- Federal, state, and local governments

Over 16% own their own business.

Many job opportunities are available that relate directly and indirectly to the automotive technology field. Opportunities directly related to automotive technology include:

- Automotive technician
- Automotive technician's apprentice
- Repair shop supervisor
- Exhaust and emissions technician
- Tune-up technician
- Service writer
- Mechanical unit repairer
- Technician in automotive manufacturing plants
- Air conditioning technician
- Engine technician
- Diesel technician
- Bus inspector
- Tractor technician
- Parts salvager
- Teacher or trainer

Note: Many graduates of automotive technology programs qualify to pursue a career as a teacher or trainer with little or no extra training required for an entry-level position.

Opportunities indirectly related to automotive technology:

- Farm equipment technician
- Aircraft technician
- Office equipment service technician/service representative
- Machinist apprentice
- Air conditioning and heating service apprentice
- Industrial machine maintenance technician
- Small engine technician
- Marine equipment technician
- Motorcycle technician

Training and Certification

Repairing and maintaining today's sophisticated vehicles requires knowledge in many diverse systems and technologically advanced areas. The days of getting a job based on performing automotive repair as a hobby or tinkering in the garage are gone. Most job opportunities require formal training in automotive technology in high school or a postsecondary school or college.

Certifying organizations

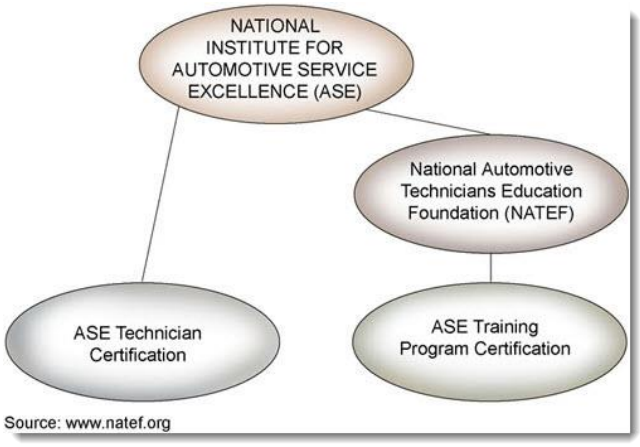
As stated on their Web site, the National Institute for Automotive Service Excellence (ASE) is a nonprofit organization that aims to "improve the quality of vehicle repair and service through the testing and certification of repair and service professionals."

Automotive technicians can be certified in one or more of the eight areas below:

- Brakes
- Electrical/electrical systems
- Engine performance
- Suspension and steering
- Automatic transmission and transaxle
- Engine repair
- Heating and air conditioning
- Manual drive train and axles

To be certified, technicians must have at least 2 years of experience and pass an ASE written examination. They must retake the exam every 5 years to maintain their certification.

The National Automotive Technicians Education Foundation (NATEF), an arm of ASE, reviews training programs to ensure they are meeting ASE standards and staying up-to-date with the continuously changing automotive technology and repair methods.



Training programs request the review process on a voluntary basis. If a program passes the review, NATEF recommends it to ASE for certification. Programs must be reviewed again every 5 years to be recertified. In ASE's automobile specialty, training programs can be certified in the eight areas listed previously.

To stay current with changes and advancements in the field, automotive technicians will need to attend training classes throughout their careers. Technicians may receive training at their workplace or may need to attend classes at a technical school or college.

Job Prospects

Prospects are very good for individuals with training and skills in diagnosis, problem solving, electronics, and mathematics. Knowledge in electronics has become crucial because most vehicle concerns involve working with or analyzing the electrical system. According to the Alliance of Automobile Manufacturers, "electronics now control more than 86% of all systems in a typical vehicle."

Many employers in the industry have reported that there is a shortage of automotive technicians and they have difficulty hiring individuals with education and experience in the areas desired. According to the Occupational Outlook Handbook, published by the U.S. Department of Labor, job opportunities for automotive technicians are expected to increase 9% to 17% through the year 2014. The growth will be due to the increased number of vehicles on the road and the loss of technicians because of retirement or advancement to specialized positions.

Work for automotive technicians is generally steady throughout the year and not very sensitive to changes in economic conditions. Therefore, layoffs are not a big concern.

Common Methods Used to Pay Automotive Technicians

- Hourly – The technician is paid for the time he or she puts in.
- Salary – A salary is a set amount of money, usually 40 hours per week, regardless of the volume of work performed.
- Flat rate – The technician is paid his or her hourly wage multiplied by the time listed for a specific job in a factory flat-rate manual or an aftermarket labor time guide. These guides are sometimes called parts and labor estimating guides. Technicians refer to these as "book hours." The technician is paid this flat rate regardless of the time spent on a job.
- Hourly plus a percentage of labor and parts

Other Facts about Working as an Automotive Technician

Automotive technicians use many different tools and equipment, including those in the following list. Technicians usually purchase their own hand tools, whereas the shop provides the more expensive power tools and equipment.

- Common hand tools
- Power tools
- Machine tools
- Welding and oxyfuel cutting equipment
- Lifts and jacks
- Computers to perform administrative tasks and access service information
- Computerized diagnostic equipment
- Measuring tools
- Test instruments
- Other specialty tools, depending on the automotive technology area

Some shops are unionized, which means that technicians employed there are subject to union rules regarding pay and other issues. For example, the technician may be required to work for 2 years as an apprentice before advancing to the journey level. The union also functions to help employees negotiate with their employers regarding salaries and working conditions.

Unit 2: Shop and Personal Safety

Chapter 1: Safe Workplace Operations

Practicing safety in the workplace takes a constant, concerted effort to understand one's surroundings and equipment. Technicians must have a thorough knowledge of the safe handling of chemicals, tools, and machinery, as well as which personal protective equipment to use for certain situations and how to maintain that equipment.

Slips and Falls

No amount of knowledge can prevent slips and falls when the workplace is cluttered, dirty, or unorganized. Most incidents of this sort can be easily prevented by simple housekeeping routines.

Slips are particularly dangerous in an automotive workplace — slipping onto dangerous machinery or while carrying a piece of equipment can be immediately fatal. A shop may be legally and financially liable for any accidents that happen as a result of negligence.

Slips are often caused by slick floors, as lubricants and other liquids used in automotive service are specifically designed to reduce friction. Elements as simple as rainwater being tracked into a shop from outside are also hazardous. No liquid whatsoever should be left on a floor - cleanup should begin as soon as there is a spill.

Drying agents and general housekeeping items should be sufficient to clean spills. Spill prevention plans should be in place to help control spills of potentially hazardous materials. Slippery areas should have a clearly visible warning sign posted nearby as soon as the slippery area is identified.

Walkways should be cleared of clutter so that people can move freely through the shop. Each tool and material in the shop has its proper place, and when not in use, it should be returned there. Walkways should be designed with safety in mind — handrails should be in place for elevations and stairs, there should be adequate headroom, and there should be ample room to keep clear of hazardous procedures. Hoses, cables, and cords should be wrapped and stored out of walkways.

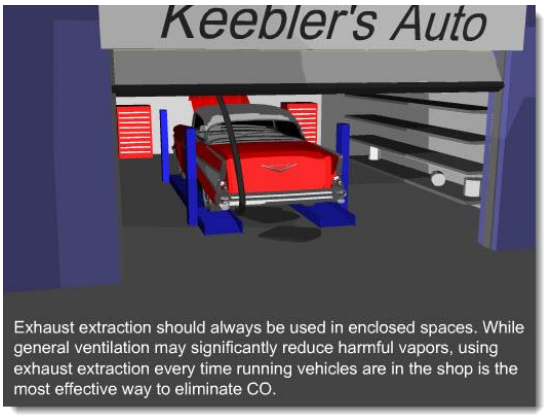
Ladders should always be used on dry, non-slippery surfaces. Be aware of the weight capacities of the ladders in your shop. Never climb up or down a ladder while facing away from it — your balance will be compromised and you can endanger yourself and those around you.

Ventilation

A well-ventilated workspace is essential to safety. Ventilation provides clean, fresh air to enclosed spaces. This is necessary to cleanse the atmosphere of harmful contaminants and improve respiration. Many methods of ventilation are available, from simple windows and fan placement to more complex exhaust and vacuum systems.

General ventilation is a simple method, most commonly achieved through windows and fans. This method dilutes the hazardous concentration with fresh air. This method can only be effective if the hazardous materials concentration is small and unchanging and the air flow sufficiently replenishes the atmosphere. Also, the hazardous material must have low toxicity and flammability levels.

General ventilation, achieved through open windows and fans, is effective when the hazardous material concentration is small and has low toxicity and flammability levels.



Carbon monoxide inhalation is a common workplace hazard. It is invisible and fills a room from the ground up. Exhaust extraction is necessary when working on a vehicle in an enclosed area. The exhaust extraction unit should be connected prior to starting the vehicle and should remain connected for the duration of the operation. Carbon monoxide inhalation can cause headaches and nausea, as well as death.

Grinding, sanding, and painting activities are all performed in areas that require proper ventilation.

Fire Safety

Fire hazards are common in automotive workplaces due to the prevalence of flammable materials. Oil, gasoline, solvents, and many compressed gases are highly flammable. In the presence of such materials, fires are quick to spark and quick to spread in a confined space.

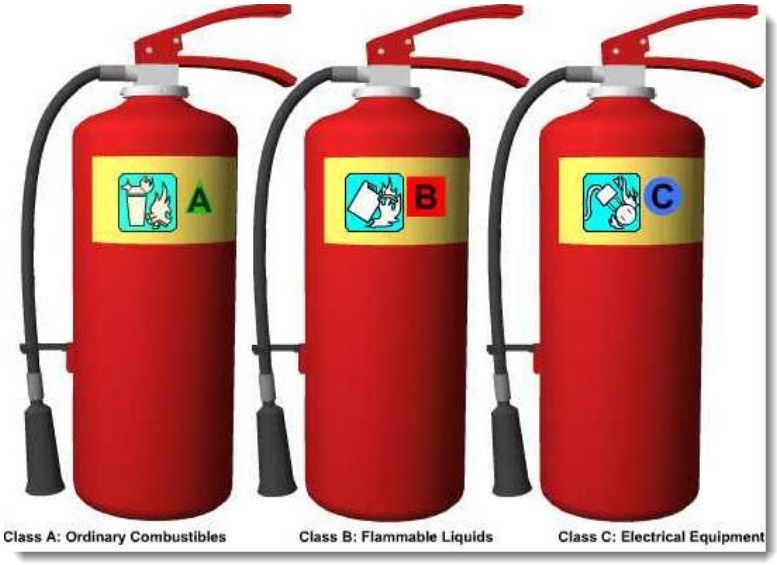
Material safety data sheets should be available for all chemicals in the workplace; these explain the dangers that chemicals pose as well as the proper handling for those chemicals. Each chemical's flammability and flash points will be detailed within an MSDS. All technicians should understand how to read and interpret an MSDS.

Open flames, flammable chemicals, and sparks all have the potential to start a large fire. Flammable materials should be kept a safe distance from any source of flame, and all areas where they are to be handled must be well-ventilated.

While the fire department should be contacted for large, dangerous fires, fire extinguishers are an important method of containment. Materials that catch fire will have different compositions and should be handled by appropriate extinguishing agents.

- **Class A fires** feature burning embers and most often occur in the presence of paper, wood, or cloth. These fires are best handled by Class A Water Extinguishers.
- **Class B fires** are results of vaporized flammable liquids, greases, and gases and require CO2 Extinguishers, which remove oxygen to eliminate the flames.
- **Class C fires** occur in electrical equipment and cannot be controlled with water extinguishers. CO2 extinguishers are often used for Class C fires because of their non-conductive qualities.

Dry Chemical extinguishers are capable of controlling multiple classes of fires and are the most common type of shop extinguisher.



Fire extinguishers should be easily accessible and never more than 50 feet away from an area in the shop. They should be mounted between 36 and 60 inches off the floor and be designated by clear, approved signs. Quick access to extinguishers can help control a fire before it spreads. Monthly inspections should be conducted to ensure gauges are full and safety pins are in place.

To use a fire extinguisher, the technician should be standing about eight feet from a fire with the extinguisher hose aimed at the base of the blaze. The pin is then pulled, after which the trigger should be squeezed. Accuracy is essential because the extinguishing spray will only last around 20 seconds.

Cleared and visible paths to the exits are essential to fire response. Effective exit strategies and proper extinguisher operation will help keep a shop and its employees safe.

Material Safety Data Sheets

"Right to Know" laws are in place to keep employees aware of the hazards in their own workplace. These laws keep businesses in compliance with health and safety legislation and ensure that employees are familiar with the hazardous characteristics and proper handling of chemicals.

OSHA requires all employers to provide Material Safety Data Sheets for all hazardous materials technicians encounter. MSDS detail potential dangers and health effects for each chemical and explain safe handling practices. Technicians should understand how to read and interpret MSDS prior to handling chemicals in the workplace.

All Material Safety Data Sheets are required to contain specific information. Some will contain more than is required, but all must meet the minimum requirements. All MSDS will contain the following:

- Chemical identity: the substance as it is identified on the label
- Manufacturer information: the substance's manufacturer name and contact information
- Hazardous ingredients: identifies hazardous contents of the substance, including chemical identity and OSHA's recommended exposure limits
- Physical and Chemical Characteristics: gravity, density, and boiling, evaporation, and melting points
- Fire/Explosion data: flammability and flash points, explosions and extinguishing information
- Reactivity: the chemical's stability, compatibility, and decomposition
- Health hazard data: routes of entry and corresponding health hazards, exposure symptoms, first aid procedures
- Safe handling: handling instructions and spill response, disposal, and storage protocol
- Control Measures: includes respiratory protection and PPE issues
- PEL - Permissible Exposure Limit: details the quantity and amount of time you can be exposed to a chemical before it becomes harmful

Some MSDS publications, like the American National Standards Institute (ANSI) have used this OSHA template and expanded their sheets to include additional material handling facts. Your facility will have information on the type of MSDS in place.

The National Fire Protection Association (NFPA) fire diamond indicates a chemical's flammability, health hazards, and instability in color-coded ratings. This and other images often appear in MSDS.

Material safety data sheets will disclose chemical-specific precautions, but there are general workplace precautions you should always remember when handling chemicals:

- Eating, drinking, and smoking around chemicals is prohibited
- Explosive and/or flammable materials must be stored away from heat sources
- Appropriate Personal Protective Equipment must be worn when handling chemicals
- Be familiar with storage, transport, and disposal procedures for all chemicals
- Only handle chemicals in a well-ventilated area
- Report feelings of nausea, headaches, or shallow breathing to your supervisor immediately

Blood-Borne Pathogens

Blood-borne pathogens pose a new kind of threat in the workplace: blood contact has the potential to transmit human immunodeficiency virus (HIV) and hepatitis B (HBV) to technicians. This is not a commonly occurring hazard, but it is one that should be addressed and prepared for.

In addition to the risk of infection from an injured coworker, repairing vehicles that have been involved in an accident exposes the technician to potentially infectious blood and bodily fluids. Being prepared for the various potential threats will reduce your risk.

Treat all blood and bodily fluids as if they are infected. PPE should be worn when handling blood or bodily fluids just as it is worn when handling dangerous machinery. Gloves and glasses will keep blood off of exposed skin. Any blood or fluid that does come in contact with exposed skin should be washed immediately, using hot soapy water.

Safety Areas and Evacuation Routes

Automotive shops are divided into work areas (stalls) and traffic areas (for vehicles and pedestrians). Some traffic areas used for emergence evacuation routes. These areas are commonly marked by strips on the shop floor and signage on the walls and doors. For reasons of safety and efficiency, technicians must be able to identify and follow the markings. A vehicle parked in an evacuation route could be very dangerous in the event of an emergency.

Technicians must also understand each of the shop's emergency procedures. The emergency procedure for a fire will be different than the emergency procedure for a tornado.

Vehicle Safety

Safe handling of power tools, machinery, and chemicals is a necessity when working in an automotive facility. It is also important to safely handle another thing commonly found in the shop: the automobile.

Technicians working on vehicles will be responsible for the safety of the vehicles as well as their own safety. Often technicians will need to drive a customer’s vehicle to move it within the facility, to troubleshoot the problem, or to confirm an operating correction has been successful. All safety precautions should be taken prior to operating a vehicle on the job: check tire inflation, adjust mirrors and seats to accommodate your driving, and wear a seatbelt. As always, never operate a vehicle while impaired by alcohol or drugs.

Working under a vehicle presents a new set of dangers. Vehicles should not be started if workers are already under it. Unless necessary, avoid working beneath a running vehicle. Do not work in direct contact with exhaust fumes under a vehicle.

When a car's brakes do not work, the drive wheels should be blocked and the car should be identified with a caution sign. The vehicle should be in the park position, or in neutral with an engaged parking brake, before starting.

Never leave the vehicle's doors open; when people are working beneath it, they can hit their heads. Open doors will also crowd walkways for passing technicians. Workers beneath a car should keep arms and legs from sticking out to prevent rolling vehicles from running over them. This will also help prevent tripping passing technicians.

A clean driving record is required when working in a transportation-related field. DUI offenses are grounds for termination. Drug and alcohol tests are given regularly to automotive technicians to maintain safe working conditions.

Hi-Voltage, SRS, and ABS Safety

Hi-Voltage Systems

Modern vehicles may have high voltage systems, in which case technicians must be able to identify related hazards and safe procedures to be followed while performing services. Hybrid vehicles have different safety procedures based on make and model. It is the technician's responsibility to locate and follow correct procedures for each vehicle.

Vehicles other than hybrids may have systems that operate using dangerous high voltage. For instance, HID lighting systems operate at more than 10,000 volts, and it is very important that technicians identify and following the correct service procedures for dealing with these systems.

SRS

All recently-manufactured vehicles are equipped with SRS (air bags) and while these systems do not operate using dangerously high voltage, they are still capable of causing injury. Technicians must identify all of the SRS electrical circuits and follow the correct service procedures and precautions when working on or near these circuits - accidently triggering an air bag will always be expensive and can cause serious injury to the technician.

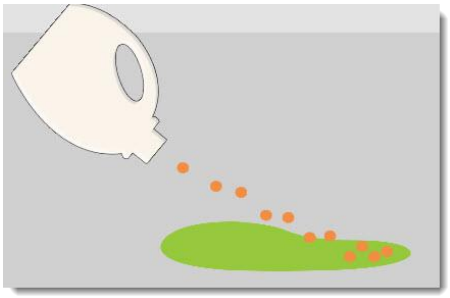
ABS

Anti-lock braking systems also contain hazardous components. The most common hazard to technicians of ABS brake systems is the high hydraulic pressure that remains in brake system components even when the vehicle is not running. Technicians must follow the correct procedures when servicing the braking system so that this pressure does not cause injury.

Chapter 2: EPA Best Practices

Absorbents

Absorbents are an essential component of managing spills in the workplace. Wet spills can be dangerous and slippery, as well as contain harmful hazardous chemicals. Absorbents that are used include a wide range of substances, including sawdust (often kept in old coffee cans or washing detergent bottles), clay, towels, and granular materials such as rice hulls or cat litter. These solid materials absorb wet spills and allow for easier spill management and disposal.



Recycling absorbents is a cost-effective option that will reduce your facility's hazardous waste generation. Non-hazardous fluids that are soaked up with towels can be wrung from the towels, which are then reused. The absorbed fluid should be stored in properly-labeled containers.

Absorbents must be treated as hazardous waste if they have been used to absorb hazardous chemicals. Containers for used absorbents are required in automotive workplaces.

Absorbents used for different chemicals should not be stored together. Each container should be labeled and dated the first time it is used. Older containers are prone to handling damage or reactions to the chemicals stored within. Secondary containment provides additional protection against groundwater and drain leaks. Weekly checks ensure the containers are not corroding.

Your shop's hazardous waste hauler will handle the disposal of used absorbent materials.

Spills Procedures

Any amount of oil or chemical waste that is released is considered a spill. If your facility allows these chemicals to leak into storm drains or the environment, you can face considerable fines. To contain the spill, block the floor drains with a cover or a temporary dam. Once you have stopped the spreading of the spill, you may then begin the cleanup.

Some spills should be treated as hazardous, such as oil, antifreeze, gasoline, and solvents. Absorbents used for hazardous materials cannot be placed in landfills. Gasoline and solvents should be cleaned up with a dry absorbent. Remember to dispose of used absorbents in labeled containers.

Spills are also a safety concern in the workplace. Slippery floors cause falls and injuries. Immediate cleanup will reduce the risk of workplace injury as well as prevent environmental contamination.

General Containment Guidelines

According to EPA guidelines, shop workers should keep the shop floor as dry as possible to minimize the amount of wastewater that is generated. Ways to keep the floor dry and clean include the following:

- Keep spills off the floor by using dedicated containers for substances like used oil and antifreeze.
- Clean up spills immediately to prevent workers from slipping in the substance and tracking it to other areas.
- Use rags to clean up small spills and dispose of the soiled rags properly.
- Use absorbent pads or mops to clean large spills and wring the substance from the pads or mops into a dedicated container for recycling or disposal.
- Use floor sweep (granules that absorb liquids) only when cleaning up hazardous waste spills such as gasoline or solvents.
- Sweep the floor with a broom every day to prevent the buildup of dirt and contaminants.
- Do not hose down the floor with water or dump mop water because the contaminants will go into the storm drain or sewer, causing pollution.
- Use water, a mop, and a mild detergent only if necessary after the spill has been removed. Check with local authorities for the proper disposal procedure.

Smaller Spills

If the spill is minor enough for you to handle, attend to it in a safe manner. Rags (three or less constitute a "small" spill) should be used to absorb these materials. Used rags should be wrung out into appropriately marked containers and stored for cleaning or recycling. Remember the procedures we discussed for rag laundering and recycling.

Medium to Large Spills

Spills that require more than three rags to wipe up should be controlled with different tools. Mops are a readily available means of spill cleanup, but different spills will require different mops for complete absorption.

When using a mop for such a spill, it is important to keep the spill contained. Typical side-to-side mop motions will spread a spill, resulting in a larger area to control and clean. Instead of this, use dabbing motions within the perimeter of the spill. By dabbing, you are pulling the spill into the absorbent mop. The spill in the mop should then be disposed of properly before you resume the dabbing.

Large Spills

Large spills must be contained as quickly and safely as possible. When a large spill occurs, it is important to notify your coworkers immediately. The spill must be assessed and handled accordingly. If the material spilled is flammable, fire extinguishers should be on hand.

The National Response Center handles major spills and accidents; they should be notified if the spill is larger than 12 gallons or 100 pounds. Local emergency response services (like the Fire Department) should be able to help control the spill, but the EPA must be notified of any environmental violations.

Refrigerants

Since the early 1990s, the Environmental Protection Agency has monitored and regulated the handling of ozone-depleting substances. Specifically, the 1990 Clean Air Act limited the emissions of such substances from motor vehicle air conditioners (MVACs).

Chlorofluorocarbons (CFCs) are common in the automotive industry—they appear in solvents, fire retardants, and refrigerants. Freon R-12 was used in MVACs until the mid 1990s, when the Clean Air Act ceased its production in favor of the more environmentally friendly R-134a. This refrigerant has a much shorter life span in the atmosphere and approximately 2 to 12 percent of the ozone depleting potential of CFCs, which for years had chemically distressed the ozone layer.

Prior to MVAC repair, the unit must be emptied of all refrigerant using approved recovery/recycling equipment. Release of CFCs into the atmosphere is illegal and can earn you and your shop hefty penalties. Freon exposure can have severe health consequences, from nausea and dizziness to blindness and paralysis. Wear appropriate PPE to reduce exposure.

The EPA has approved equipment for recovery and recycling of MVACs in conjunction with the Society of Automotive Engineers' approval standards. The EPA publishes a list of approved refrigerant reclaimers for MVACs; technicians should see to it that only approved machinery and reclaimers are employed when handling refrigerant. There is no single national standard for antifreeze recycling, so your shop should have methods in place that meet your local agencies' requirements.

Technicians must be certified in the EPA's Clean Air Act Section 609, which details approved equipment and handling procedures. Certification should be carried or available at the shop when working on MVAC systems.

Alternate refrigerants may be used if they comply with the EPA's Significant New Alternatives Policy (SNAP). Alternatives are studied for their environmental ozone threats and possible toxicity characteristics. Your shop should consult the EPA's regularly updated list of approved alternatives:

www.epa.gov/ozone/snap/refrigerants/lists/mvacs.html

Catalytic Converters

Catalytic converters reduce emissions from vehicle's tailpipes and must not be removed prior to their warranty expiration date.

Catalytic converters installed in vehicles prior to 1995 were under manufacturer's warranty for five years or 50,000 miles. Since then, catalytic converters have been installed with eight year / 80,000 mile warranties. Technicians should not install aftermarket catalytic converters before the warranty expires.

Replaced catalytic converters should be kept onsite for at least 15 days, labeled with information on the car from which it was removed. Dated work orders can be attached to the converter. Catalytic converters are easily recycled for their metals.

The facility should retain completed paperwork on the installation for at least six months. This paperwork should include the work order and customer invoice, including the customer's name, address, the vehicle's make, model, and mileage, and reasons the catalytic converter was replaced.

Brake Repair and Asbestos

Asbestos has been used in the automotive industry for years because of its nonflammable, sturdy design. Tiny fibers provide a resilient surface for friction-based moving parts, like clutches and brake linings. Asbestos can handle the high temperatures friction produces without burning; instead it wears slowly and visibly, in the form of dark dust. The dust produced by worn asbestos can pose dangerous risks if it becomes airborne. Cancer and the lung condition mesothelioma have been attributed to prolonged asbestos inhalation.

By its nature, asbestos dust can easily disperse into the air, even during minor, seemingly safe procedures. Asbestos dust is prone to scattering during attempts at cleanup. Wet rags and solvents will contain the dust momentarily, but the fibers will loosen and float again as the rag or solvent dries.

Some precautions to reduce the risk of asbestos inhalation:

- Using hand tools in place of air or power tools will reduce the air displacement
- Never blow asbestos dust from a surface
- Use a High Efficiency Particulate Air filtration to ventilate area of dust
- Wear approved respirators and PPE

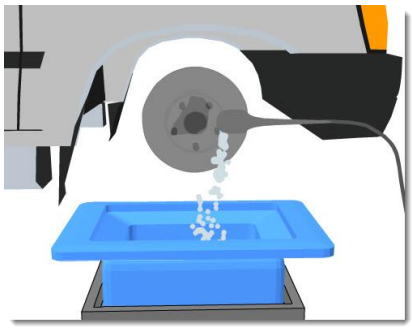
Solvents used in brake repair will likely require hazardous waste handling, but due to their flammability, not because of asbestos-related reasons.

Brake pads containing asbestos should be recycled or reclaimed if possible. Companies that will recycle or reclaim these pads should be notified of the asbestos presence. Only landfills and disposal sites that are approved for asbestos should be used if you are not recycling or reclaiming the pads.

Asbestos-containing brake pads must be in sealed, labeled containers (name and location of the waste generator) if they are to be disposed of in EPA-approved landfills. Vehicles transporting the asbestos must also be clearly labeled during loading and unloading. Make sure all shipment records are accurately maintained.

Brake Washing

When washing brakes, it is important to keep asbestos dust contained. Wet brake washers are often portable and can prevent dust from dispersing into the air. Dry brake cleaning equipment is designed to cover the brake in a sealed enclosure while a vacuum air system removes the dust.



High Efficiency Particulate Air (HEPA) filtration systems are the most effective vacuums for asbestos dust removal; their filters are able to capture the microscopic fibers. HEPA systems are often used in dry-type brake cleaning. In this process, the brakes are enclosed in sealed equipment and dust is removed through the vacuum.

HEPA vacuum filters must be disposed of as hazardous waste; they should be sealed in leak-free wrapping. The filters should be labeled as asbestos and warn of its health effects.

Repairing clutches puts technicians in direct contact with asbestos dust because they must be underneath the clutch to reach it. The technician should wear all appropriate PPE (goggles, respirator) when under the clutch.

Clothes worn during asbestos exposure should be laundered immediately. Some automotive shops offer on-site laundering service. No technician should leave work without washing his or her hands and face, and changing clothes.

Chapter 3: Waste Handling and Disposal

Hazardous Wastes

Hazardous wastes are discarded materials defined by the Environmental Protection Agency as “solid waste,” including solids, semisolids, liquids, or contained gaseous materials. Listed wastes and characteristic wastes are regulated under the Resource Conservation and Recovery Act (RCRA).

Listed wastes are known to have harmful effects on humans and the environment when managed improperly, regardless of their concentrations. Spent cleaning solvents often contain listed wastes. Chlorinated compounds in spent halogenated solvents qualify as listed wastes, as do xylene, methanol, ethyl ether and methyl isobutyl ketone in spent non-halogenated solvents.

Some waste is not classified as a listed waste but is still considered hazardous. These wastes are identified by their hazardous characteristics:

- Ignitable wastes, including used paints, degreasers, oils, and solvents, are flammable or prone to spontaneous combustion. Ignitable wastes have a flashpoint of less than 140° F.

- Corrosive wastes are capable of corroding metal storage, like tanks, drums, and barrels. Acids with pH less than 2 and bases greater than 12.5 fall into this category; such wastes are present in battery acid, rust removers, and many workplace cleaning fluids.

- Reactive wastes, like lithium-sulfide batteries and explosives, are unstable and are prone to explode or produce toxic vapors and fumes when mixed with water.

- Toxic chemicals have high concentrations of heavy metals and are often fatal when ingested or absorbed.

Acutely hazardous wastes are classified as hazardous regardless of proper management. These wastes, which include pesticides, are so hazardous that any exposure can be life-threatening.

Many operations in the automotive workplace will generate waste. All wastes not recognized as a listed hazardous waste should be evaluated for hazardous characteristics. Consulting the MSDS for products involved in each operation will often reveal characteristics to help you determine its status.

Solvents

Solvents are liquids that can dissolve other substances. Repair facilities rely on solvents for many tasks, most commonly for equipment or parts cleaning. Halogenated solvents are common in automotive repair shops, especially methylene chloride, trichloroethylene, and 1,1,1-trichloroethane. When using any halogenated solvents, operators must submit a notification report to local air quality authorities. National Emissions Standard for Hazardous Air Pollutants (NESHAP) standards require that a facility declare their solvent cleaning machines and an estimate on annual solvent usage.

Solvents can be stored in compatible containers with a lid and kept closed. The container should be labeled clearly for storage or transport. Solvent containers should be checked weekly for leaks.

Technicians should wear appropriate PPE and stay in well-ventilated areas when using solvents. Half-mask air-purifying respirators with organic vapor cartridges are recommended, as well as chemical-resistant gloves. Solvents contain highly toxic liquids that pose a threat to both you and the environment. Common solvents in the auto shop are listed below:

- Toluene is a volatile organic solvent and a hazardous air pollutant used in automotive paints and thinners. Extended exposure to toluene can damage the nervous system and kidneys, and high level exposure in a short time can cause memory loss, nausea, weakness, unconsciousness, and death, among other things.
- Ethyl benzene exposure can cause similar complications, though less is known about its long term effects. Headache, eye and skin irritation, potential coma, and death are related effects. This chemical is used frequently in paint manufacturing and spray painting operations.
- Other chemicals have shown to cause occupational asthma, nerve damage, and cancer.

Automotive repair shops should dispose of their spent solvents according to the EPA's waste regulations. Spent solvents should never be emptied into drains or dumpsters. If the facility does not contract an outside handler of spent solvents, it must determine if the solvents are hazardous. Licensed recyclers and disposal companies should handle the solvents once you have properly stored and labeled them. Sludge generated from solvents used in parts cleaning may also be hazardous. If the sludge is determined to be hazardous, it must be handled accordingly.

Hardeners

Diisocyanates are molecular compounds of two or more isocyanate groups. Most commonly found in hardeners and polyurethanes, these coatings have high mechanical resistance and are resistant to chemicals and weather. Because of their versatility and performance, they are commonly used in automotive painting procedures.

Technicians responsible for painting and sanding operations will have the most direct contact with diisocyanates. Exposure to diisocyanates has been shown to cause skin irritation, respiratory sensitization, and may cause cancer. Sensitization is a condition that makes workers prone to asthmatic reactions with even minimal exposure, and diisocyanates are the leading cause of occupational asthma.

Diisocyanates should be handled in isolation when possible. If machinery allows for operators to avoid contact with isocyanates, it should be used. Closed system or exhaust ventilation are recommended to reduce harmful isocyanate particles in the air. HVLP spray guns and down-draft spray booths are effective means of lowering diisocyanate exposure.

NIOSH-approved respirators should be worn whenever handling these chemicals. Other PPE recommended to reduce skin exposure include safety goggles and chemical-resistant gloves.

Workers who come into contact with isocyanate contacts should observe rigorous decontamination procedures. Soap and clean water should be used on skin, while exposed eyes should be flushed with clean water. All clothing should be laundered completely before it is used again.

Antifreeze

While new antifreeze is not classified as a hazardous waste, used antifreeze often contains high levels of heavy metals. Engine remnants of lead, cadmium, chrome, and benzene often appear in used antifreeze, and these qualify as hazardous waste. Though testing may indicate no metals are present in used antifreeze, it is quicker, safer, and more economical to treat all used antifreeze as hazardous.

Because we are treating used antifreeze as a hazardous waste, it must be disposed of as such. It is illegal to pour antifreeze outdoors or into plumbing and septic systems. Used antifreeze should be stored by itself in tight, leak-free containers. Labels should indicate its antifreeze contents to distinguish it from used oil storage. Often there are standards limiting the amount of antifreeze a facility can store, however, so check with local agencies before storing.

Whenever possible, used antifreeze should be recycled. Recycling is the most cost-efficient and environmentally safe way to handle used antifreeze.

Reclaiming is the preferred method of antifreeze recycling. Piping extracts the used antifreeze and filters it through a Closed Loop System; afterward it is returned to the radiators. The antifreeze may still be hazardous, but because it is returned to its original use, is not considered a hazardous waste. The non-closed system removes the used antifreeze to a drum, where it should be stored according to hazardous waste regulations.

Other means of recycling will involve contracted services that can legally remove and transport the used antifreeze. If these methods are used, your facility should have protocols in place for reference.

Used Batteries

Because used batteries contain lead battery acid (toxic) and sulfuric acid (corrosive), they are classified as hazardous waste. Used batteries should be recycled. Your workplace should have an active battery recycle program. Improper disposal of used batteries is a violation of EPA law.

Recycling used lead acid batteries also helps reduce your shop's hazardous waste generator status — the weight of a few batteries can reclassify a facility as a large quantity hazardous waste generator.

When handling spent batteries, it is important to take several precautions. Remember, lead battery acid is a hazardous material. Often batteries are leaking or have been cracked or broken. These should be neutralized immediately; upon removal they should be stored in an acid-resistant tank and submersed in baking soda or vendor-supplied neutralizing agents.

Tips for safe handling and disposal of batteries:

- Technicians should always wear safety glasses and acid resistant gloves to protect from possible explosions or acid leaks
- Batteries should only be stored on acid-resistant shelves and should never be stacked atop each other. Cracked or broken batteries can leak and drip acid.
- Wooden pallets may be used only if they are placed on impermeable surfaces.
- Do not store batteries near inside drains or exterior storm drains.
- Damaged batteries should be stored in a leak-free tub to ensure no leaking acid is released. The tub should be acid-resistant and should be stored in a covered, secure location.
- Secondary containment is necessary to prevent battery acid from contaminating soil or water.

Used Oil and Oil Filters

Oil

Used oil is responsible for widespread pollution and environmental hazards. It spreads easily and is quick to contaminate large amounts of water and soil. While not typically classified as hazardous, used oil should always be recycled or reclaimed according to state requirements.

The Used Oil Standards regulate the recycling, disposal, and storage of used oil. These standards are not limited to spent motor oil; any petroleum-based oil or synthetic oil is considered oil, including transmission fluids and lubricants.

Oils are contaminated in the vehicle by engine metals, water, dirt, and chemicals that can render the oil hazardous. Oil can be recycled, however, and then will not be subject to hazardous waste regulations. When it is stored, used oil should be clearly labeled in a leak-free container. Used oil should not be mixed with hazardous materials.

Oil can be reused many times, so recycling the used oil is both environmentally sound and financially beneficial. Some facilities choose to recondition their oil on-site, which will rid the oil of its impurities. If the facility re-refines its oil, it can be used as base stock for lubricating oil.

Used oil can also be burned as a method of energy recovery. After the water has been removed, used oil can be burned to fuel space heaters. Consult with regulatory agencies to ensure no harmful air emissions result from the burning.

Whenever oil is handled, there are common standards developed by the EPA that should be observed, regardless of process, quantity, or hazardous characteristics of the oil. These include:

- Keeping all oil storage containers in good condition, without leaks or signs of wear
- Storing all used oil containers on flat, impenetrable surfaces (asphalt or cement) to prevent oil from spreading or seeping into the ground
- Labeling all containers and storage with clear, visible “used oil” signs
- Shipping used oil to any offsite location requires transporters with EPA identification numbers

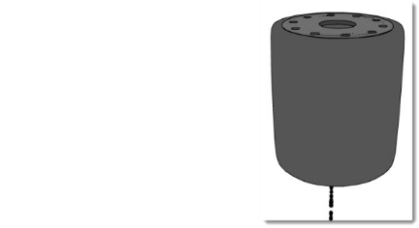
Storing used oil is no different from storing hazardous materials in the workplace—it should be stored in labeled containers separate from hazardous waste. Once used oil has been stored with hazardous waste it can no longer be recycled and must be disposed of as hazardous waste.

Oil Filters

Used oil filters can be terne-plated or non-terne-plated. Terne-plated filters contain lead and tin; therefore they must always be treated as hazardous waste. Used oil filters that are not terne-plated will be exempt from federal hazardous waste requirements if they are properly drained. Hot draining is the preferred means of removing residual oil, and filters that have been hot-drained can be disposed as solid waste.

Hot-draining involves removing the filter from a warm engine and immediately draining it. Acceptable methods of hot draining:

- Gravity Draining: the filter should be removed and placed gasket-side down in the drain pan. Puncture the filter and its anti-drain valve. The filter should drain until it is empty for 12 to 24 hours at a minimum of 60 degrees.



- Crushing: the filter can be crushed to squeeze out used oil prior to recycling.

- Disassembly: the filter should be disassembled and each separate part allowed to drain. The filter's parts can be recycled separately.
- Air Pressure: oil can be removed from a filter by an air pressure device.

All drained oil should be stored and clearly labeled. Usually, used oil can be stored with other oils for recycling (transmission oils, synthetic oils, petroleum-based oils, and lubricating fluids). Used oil should never be mixed with hazardous materials; this will render the entire container hazardous. Gasoline, paints and paints thinners, antifreeze, wastewater, and wastes of unknown origins should be stored separately and handled as hazardous. Used filters should be recycled by scrap recyclers or disposed of in solid waste landfills.

Gravity-draining will also clear spent transmission filters and fuel filters of hazardous waste characteristics. These, too, can be disposed of as solid waste.

Filters from antifreeze recycling units may be considered hazardous waste. Testing the filters for metals will determine their hazardous status. If they prove to be hazardous waste, antifreeze filters must be disposed as such. Non-hazardous antifreeze filters can be disposed of as solid waste.

Used Rags

Towels and rags are subject to hazardous waste standards if they have been used with gasoline or antifreeze, or if they demonstrate hazardous characteristics such as ignitability or toxicity. If so, they can be washed by a professional laundry service or can be disposed of at approved facilities.

Professional laundering services will have guidelines for contaminant and volume intake.

Storing oily rags in airtight metal containers will reduce the risk of spontaneous combustion, which occurs when oxygen raises the internal temperature of something to its ignition point.

Rags that are reusable should be handled in an environmentally safe manner as well:

- Soaked rags should have their fluid wrung out into proper containers; no dripping rags should be stored.
- Used dry rags should be stored in approved containers clearly labeled for “used solvent rags only”.
- Do not store rags used with different solvents in the same container
- Do not store rags with any other waste
- Rags should not be disposed of in landfills.

Used rags contaminated with oil can often be burned, under the Used Oil Management Standards, as an energy recovery method. Until the oil is removed from such rags, they should be handled like used oil. EPA standards dictate that used oil has been efficiently removed when it no longer flows freely from wrung rags.

Used Tires

While not classified as hazardous waste, used tires pose harmful environment consequences if not properly disposed. Pests and rodents are prone to live in stacks or piles of dumped tires. Mosquitoes breed in water collected in dumped or stacked tires, and the threat of mosquito-transmitted viruses, like the West Nile virus, has become increasingly stronger.

Burning tires pose the greatest threat. Used tires stored in piles or stacks are very hard to extinguish. As they burn, the tires emit petroleum clouds into the atmosphere and deposit contaminated oil into the earth. Soil and groundwater contamination resulting from this requires extensive remediation.

Water will not extinguish a tire fire. Wetting adjacent tires to prevent them from igniting is useful, but to control the fire itself, sand or dirt should be poured on top. Smothering the fire is the most effective means of extinguishing the blaze.

Unit 3: Cleaners and Lubricants

Chapter 1: Cleaners, Lubricants, and Specialty Chemicals

General Rules for Using Chemicals

There are many different types of chemicals used in automotive technology. This lesson will look specifically at some of the more common types of solvents, soaps, and cleaning solutions. First, let's look at some basic rules that apply to working with any type of chemical.

- Follow the manufacturer's recommendations.
- Carefully read the product label for correct uses and hazards.
- Work to prevent spills, damage to the vehicle, or unsafe situations/conditions.
- Properly store chemicals and used rags.
- Use chemicals only for the intended purposes.

CAUTION: Consult the instructor before using an unfamiliar product.

Types and Uses of Solvents and Cleaners

Petroleum-based **parts-washing solvent** dissolves oil, grease, and varnish from engine components and other parts of the vehicle. It is usually dispensed in a parts-washing tank that filters and recycles the solvent.

This solvent contains **volatile organic compounds** (**VOC**s) that give off toxic vapors and must be managed as a hazardous waste. Parts-washing solvent is not as flammable as some other solvents, but can burn and does present a fire hazard. Keep electrical devices, sparks, and any hot material away from the parts-washing tank. The solvent tank should be equipped with a safety link, which will melt should the solvent ignite. When the safety link melts, the lid on the washer tank will close and smother the fire.

Parts-washing solvent presents a hazard to the eyes and skin, especially when the solvent is fresh. Breathing solvent vapors is also a health risk. Wear **personal protective equipment** (**PPE**) when working with the solvent.

CAUTION: Some technicians may have a severe allergic reaction to the parts-washing solvent.

Petroleum-based parts-washing solvent can melt some shoe rubber and should never be splashed or poured on the shop floor. If a solvent spill is not immediately wiped up from the floor, it can cause people to slip and fall. Never put units such as electric motors in the solvent tank. Such units may sustain insulation damage; they may also be hard to dry on the inside. To extend the usable life of the solvent and to prevent clogging the tank, remove most of the grease, gasket material, and dirt from parts before washing. Never pour other liquids into the solvent tank.

Parts-washing solvent (aqueous-based)

Aqueous-based **parts-washing solvent** is used for the same purposes as the petroleum-based solvents, but it is typically nonflammable and contains less than 5% VOCs. Besides water, the ingredients in aqueous-based solvents generally include a detergent, corrosive substance, or alkaline agent and a rust inhibitor. Rather than dissolving grease and solids with chemicals, aqueous solvents use heat, agitation, and detergents to clean automotive parts.

Special cleaning equipment is required that heats the aqueous solvent and sprays it with great force. Spray cabinets, which are totally enclosed, are best for cleaning heavily soiled parts or a large number of parts. Sink-top units are used for more lightly soiled parts or fewer parts. The life of the solvent can be prolonged by using filters, maintaining the solvent's concentration, and skimming grease from the solution. Aqueous solvent may become hazardous waste through use. Waste disposal professionals must analyze the solution to determine how to dispose of it safely.

Choke and throttle body cleaner

Choke and throttle body cleaner is an aerosol product that is more aggressive than parts-washing solvent in cleaning oil, grease, and varnish from carburetor components and other small precision-machined parts. It is a petroleum-based product. Choke and throttle body cleaner is extremely flammable and presents a dangerous fire hazard. Never spray the cleaner on hot engine parts or around sparks or fire. The cleaner can also damage paint. Do not spray the cleaner near the body of the vehicle or other painted components. Choke and throttle body cleaner can damage eyes and irritate skin. Breathing its vapors is also hazardous. Always wear PPE and spray the cleaner away from the body so that vapors are not inhaled and the cleaner does not contact the skin. Observe the safety warnings on the cleaner can. Do not expose the cleaner can to heat under any circumstances because heat will cause the cleaner can to explode.

Brake cleaner

Brake cleaner is an aerosol product that is extremely effective in removing grease and oil from brake drums, rotors, and engine flywheels. Brake cleaner is extremely flammable and presents a severe fire hazard because the cleaner is sprayed from an aerosol can. Brake cleaner can damage paint. Do not spray the cleaner near the body of the vehicle or other painted components. Brake cleaner can damage eyes and irritate skin. Breathing its vapors is also hazardous. Always wear PPE and spray the cleaner away from the body so that vapors are not inhaled and the cleaner does not contact the skin. Observe the safety warnings on the cleaner can. Do not store brake cleaner in a hot area. Do not expose the can to heat under any circumstances because heat will cause the cleaner can to explode.

Gasket remover

Gasket remover is an aerosol product that loosens gasket material that may be tightly stuck to engine components with sealers or glue. Gasket remover is extremely flammable and presents a serious fire hazard because the gasket cleaner is sprayed from an aerosol can. Gasket remover can damage paint. Do not spray the remover near the body of the vehicle or other painted components. Gasket remover can damage eyes and irritate skin. Breathing its vapors is also hazardous. Always wear PPE and spray the cleaner away from the body so that vapors are not inhaled and the cleaner does not contact the skin. Observe the safety warnings on the gasket remover can. Do not store gasket remover in a hot area. Do not expose the can to heat under any circumstances because heat will cause the gasket remover can to explode.

Gasoline

Gasoline is intended for use as a fuel, not as a cleaner for automotive parts. Do not use gasoline as a solvent.

CAUTION: Never use gasoline or other chemicals for purposes other than those listed on the product can or container. Consult with the instructor before using any solvent or chemical.

Gasoline fumes can cause similar health problems as cleaning solvents and contribute to hydrocarbon emissions. The fumes are also extremely flammable and, if ignited, can cause severe burns or death. Prolonged exposure to liquid gasoline has been shown to cause cancer in laboratory animals. Gasoline additives can leave harmful deposits on important engine components.

Specialty cleaning agents

There are many specialty cleaning agents that may be used in automotive technology. As with all chemicals, follow the manufacturer's recommendations and only use the cleaners for their intended purpose. Some examples include the following:

- Spot remover
- Bug and tar remover
- Upholstery cleaner
- Carpet cleaner
- Vinyl cleaner and conditioner
- Battery cleaner
- Wire wheel cleaner
- White sidewall cleaner

Oils

General rules for using oils

Oil is a petroleum-based or synthetic product that lubricates parts or acts as a hydraulic fluid. When using oil, follow the precautions below.

CAUTION: Wear personal protective equipment (PPE) when working with oils.

All types of oils can represent a significant fire hazard. Spontaneous combustion, fire initiated without flame, can and does occur with rags soaked in any type of oil. Oil must be stored in a designated area away from heat, flame, or sparks. Oily rags must be stored in a metal safety container with an airtight lid built for this purpose. Oil can ignite at any temperature above 0° when mixed with pure oxygen. Oil must never be applied to oxyacetylene welding equipment. Immediately use or discard bottles and cans that are leaking oil.

If oil is dripped or spilled on the shop floor, clean it immediately to prevent slipping. Wipe up small spills or drips with a towel. Larger spills may need to be absorbed with sawdust or oil absorbent granules and then swept up and discarded. If necessary, scrub remaining slickness with soap and water. Drain pans help to prevent oil spills.

Avoid prolonged contact with oils. Short-term contact can cause irritation, chapping, or drying of the skin. Long-term contact can cause a variety of skin diseases that includes cancer.

Light or penetrating oils

Light or penetrating oils are aerosol products that include rust-penetrating oil, silicone lubricant, liquid graphite, and belt dressing. Light oils are used to lubricate precision parts because the lubricant gets into tight clearances and does not attract as much dust and dirt as heavier oils. Because they can dissolve some rust, rust-penetrating oils are used to aid in the removal of rusty bolts and fasteners. Liquid graphite dries to a slick, black coating that does not attract any dust or dirt. This makes it desirable for components with tiny moving parts, such as locks. Belt dressing is sprayed on drive belts to prevent slippage and quiet belts that dry out and get noisy.

CAUTION: Aerosol cans are pressurized. The can must not be punctured or crushed, even when empty. The can should not be stored near heat or sparks. Never spray these products towards the body.

Standard and heavy oils

Standard and heavy oils are motor oil, automatic transmission fluid, power steering fluid, and gear lube.

Motor oils are used in vehicle engines and classified by viscosity or weight (e.g., 10W-30) and a two-letter grade (e.g., SJ and SL). Refer to the manufacturer's recommendation for the correct viscosity and service classification for the vehicle being serviced. Refer to the vehicle service information for the proper interval for changing the motor oil.

Automatic transmission fluid (**ATF**) is available in three main types: Type F, Dexron III, and Mercon V. ATF is used in all automatic transmissions and some manual-shift, front-wheel-drive transaxles. Some vehicle manufacturers recommend using only their products that include specific additives. Refer to the manufacturer's recommendation when selecting and using ATF.

Power steering fluid is similar to ATF. Refer to the manufacturer's recommendation when selecting and using power steering fluid.

Gear lube is thicker than motor oil or ATF and provides superior lubrication between the large and highly stressed gears of manual gear boxes and differentials.

Hydraulic fluids

Hydraulic fluids include hydraulic jack oil and brake fluid.

Hydraulic jack oil is used in shop equipment that has a hydraulic cylinder, such as jacks, engine hoists, lift racks, and forklifts.

CAUTION: Do not add hydraulic jack oil to shop equipment without the permission and supervision of the instructor.

Brake fluid is added to the master cylinder reservoir and clutch master cylinder in a hydraulic clutch system. In America, brake fluids must be rated at DOT-3 (Department of Transportation Specification #3) or DOT-4. Using the incorrect brake fluid can result in brake fade, the deterioration of rubber seals, or complete brake failure.

Most hydraulic fluids, especially brake fluid, attack and dissolve paint. Cover fenders when adding brake fluid. Thoroughly wash hands immediately after contact with brake fluid.

Note: If you suspect that brake fluid has contacted a painted surface, immediately wash that surface with soap and water.

Hydraulic fluids, especially brake fluid, must be capped tightly to prevent dirt and moisture from contaminating the fluid. Small amounts of moisture can turn to steam when brake fluid becomes hot during brake application. The steam reduces the effectiveness of the brakes. Hydraulic fluids must be stored in a designated area away from heat, flame, or sparks. Never substitute other types of oil for hydraulic oil. Nonhydraulic oil may harm rubber seals or fail under the heat generated by the brake system.

Greases

General rules for working with greases

Grease is used when a lubricant must stay on parts for a long period of time and endure high pressure. When working with grease, follow the precautions below.

CAUTION: Wear PPE when working with greases.

Greasy rags are subject to spontaneous combustion. Greasy rags must be stored in a metal safety container with an airtight lid built for this purpose. Grease products must be stored in a designated area away from heat, flame, or sparks. Wipe up grease spills and clean the area immediately with soap and water. Avoid prolonged contact with greases. Short-term contact can cause skin irritation, chapping, or drying of the skin. Long-term contact can cause a variety of skin diseases that includes cancer.

Types and uses of greases

Multipurpose grease is suitable for lubricating such items as steering linkage components and wheel bearings. Multipurpose grease can also be used as an assembly glue when packing bearings into a manual-shift transmission. Read the information on the lubrication label before using multipurpose grease to be sure that it is recommended for the planned application.

Wheel bearing grease is suitable for steering linkage components as well as wheel bearings. If packing wheel bearings in a disc brake or high heat application, use an extreme-pressure (EP) wheel bearing grease compatible with the disc brakes.

Brake grease is applied in small amounts to the backing plate on vehicles equipped with drum brakes.

Cam lubricant is sometimes included with a new camshaft. The lubricant can help with breaking in the camshaft.

White lithium grease is a general-purpose lubricant available in a tube or aerosol can. Uses of white lithium grease include hood hinges, door hinges, cables, linkage, and shop equipment maintenance.

Stick lubricants are used on door strikers because they do not stain clothes.

Some light-colored greases, such as white lithium grease, are not compatible with ATF and should not be used as an assembly glue or as a prelube for internal transmission parts.

CAUTION: If noncompatible grease is used during automatic transmission assembly, components in the valve body of the transmission can become stuck, resulting in shifting problems.

Dielectric grease, available in a tube, is used to seal electrical connections to prevent voltage leakage and keep out dirt, corrosion, and moisture.

Brake system silicone compound is a greaselike lubricant that comes in a tube. It is used to lubricate sliders, rubber parts, or plastic parts on brake systems.

Types and Uses of Specialty Additives

Specialty additives include oil treatment, gas treatment, transmission conditioner, and starting ether. Refer to the container label for hazard warnings and handling procedures.

CAUTION: Wear PPE when working with specialty additives.

Oil treatments are used to raise motor oil viscosity or to free sticking valves or lifters. Raising the motor oil viscosity can extend engine life by increasing oil pressure.

Note: Adding too much oil treatment can result in poor lubricating properties or oil that exceeds the proper viscosity, especially in cold weather.

Gas treatment is used to help reduce moisture in gasoline and eliminate buildup of carbon, gum, and varnish in fuel lines. Gas treatment usually contains alcohol. Excessive amounts of methanol can destroy rubber carburetor or fuel system components and damage the lining of the fuel tank.

Transmission conditioner is added to automatic transmission fluid to prolong the life of the fluid and improve the shifting performance of worn transmissions.

Starting ether is sometimes used to start an engine in extreme cold. The directions for using starting ether must be followed carefully.

CAUTION: Starting ether is extremely flammable and can create an explosion if the engine backfires.

Types and Uses of Specialty Chemicals

There are numerous **specialty chemicals** used in automotive technology. Common specialty chemicals include sealers, locking and antiseize compound, and adhesives.

CAUTION: Wear PPE when working with specialty chemicals.

Sealers

The two types of sealers are hardening and nonhardening. **Hardening sealers** form a hard seal between components. They are used to seal permanent assemblies and to fill gaps in irregular surfaces. **Nonhardening sealers** remain pliable. They are used in areas that are exposed to vibration, expansion, and contraction.

Room temperature vulcanizing sealer RTV, typically available in a tube, is a special rubber that sets up at room temperature and forms a seal between components. RTV is used instead of a rubber or fiber gasket. It is aerobic, which means it cures when exposed to air.

Note: Some RTVs cannot be used on engines in vehicles equipped with components such as oxygen sensors or automatic transmissions.

Gasket sealers, applied with a brush or from a tube, help to ensure a good seal between gaskets and irregular surfaces. These sealers are anaerobic, which means they will cure only in the absence of air.

Thread sealant is used to seal threads and bolts that are exposed to liquids, usually either lubricating oil or coolant.

Locking and antiseize compounds

Locking compounds prevent a fastener from loosening by acting as a lock washer. Locking compounds have various strengths that range from "wrench removal" to "permanently bonded."

Antiseize compounds prevent threaded fasteners from becoming permanently bonded to another component and are used when the fastener is made of a different type of metal from the component to which it is attached.

Adhesives

Two common adhesives are **weather strip and gasket adhesive** and rearview mirror adhesive. Weather strip and gasket adhesive is used to glue gaskets to metal and weather strips to the vehicle's doors and trunk. **Rearview mirror adhesive** is used to glue inside rearview mirrors to the windshield.

Unit 4: Tools and Equipment

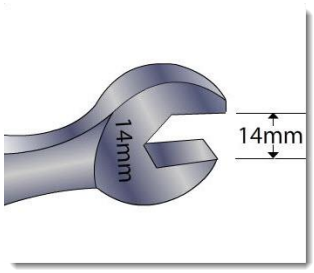
Chapter 1: Tools

Types of Wrenches

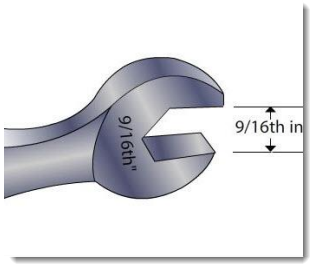
Metric and U.S. Customary System (USCS) Wrenches

All technicians should have a set of both metric and USCS (also called SAE) wrenches for loosening and tightening bolts and nuts.

Metric wrenches are sized per the measurement in millimeters (mm) of the jaw opening, from face to face. The jaw size is actually a little larger than the bolt or nut of the same size to allow the jaw to fit around the bolt or nut.



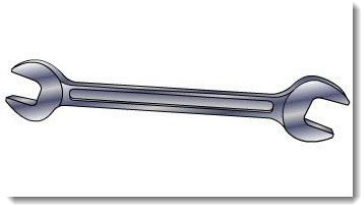
USCS wrenches are sized per the measurement in fractions of an inch of the jaw opening, from face to face. The jaw size is actually a little larger than the bolt or nut of the same size to allow the jaw to fit around the bolt or nut.



Metric and USCS wrenches are not interchangeable. For example, if removing a 14-mm nut, a 9/16-in wrench is close in size but is not the proper size to effectively remove the nut. The 9/16-in wrench may slip and round off the sides of the nut. A 14-mm wrench should be used.

Common Wrenches

The **open-end wrench** turns nuts and bolts that have already been loosened. If too much torque or turning action is applied, it can round off the corners of nuts or bolts. The ends of the wrench are set at a 15° angle to reduce the distance the wrench is moved to grip the next side of the hex head.



The **box wrench** completely encircles the nut or bolt to grip all the corners, which allows considerably more torque to be applied without stripping the nut or bolt. This wrench is particularly useful for loosening tight bolts and nuts. More time is required to turn loose bolts with the box wrench.

The **combination-end wrench** is a combination open-end and box wrench. It is a favorite of technicians because of its multiple uses.

A **tubing wrench**, or **flare nut wrench**, has ends with a portion of one side cut away so that the wrench may be slipped over a steel line. Each end partially encircles the hex head of a nut or bolt. Steel line fittings are usually brass and require this type of wrench to loosen a tight fitting without causing damage.

Note: In addition to the tubing wrench, an open-end wrench is used to firmly hold the fitting while attaching it to the steel line. Do not allow the steel line to become twisted.

Maintenance

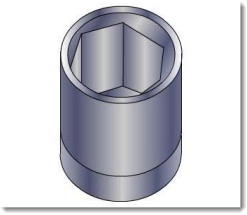
- Wrenches should be kept free of dirt and grease and stored in a dry place to prevent rust.
- Wrenches with distorted jaws should be discarded.

Safety

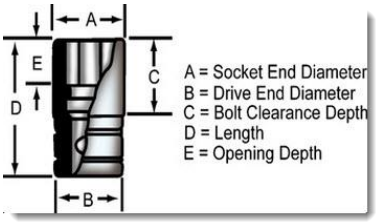
- Always use the proper size wrench. Do not use metric wrenches on USCS bolts or vice versa.
- Do not use a wrench as a hammer or pry bar.

Socket Wrenches

This wrench is so named because it has a cylindrical socket (in the size of the bolt) that fits down over the bolt, much like a box-end wrench. The **socket wrench** is the preferred tool of most technicians when they work with nuts and bolts. Socket wrenches can be used in places that are inaccessible to common wrenches and are faster at removing bolts.



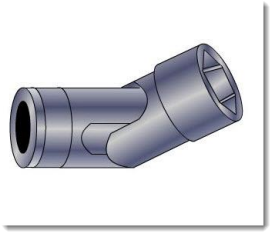
The two basic parts of a socket wrench are the socket and bar or handle. Sockets come in metric and USCS sizes and are sized according to the size of the bolt head they fit and the size of the bar they take. They are available in four point types: 4 point, 8 point, 6 point, and 12 point, with the 6-point and 12-point sockets being the most commonly used.



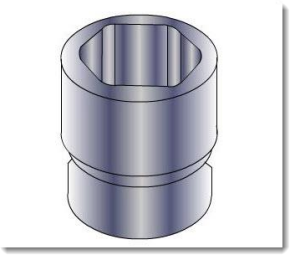
- A shallow 12-point socket is used for turning hexagonal bolt heads in tight places because it offers twice as many starting positions.
- A shallow 6-point socket is used for turning hexagonal bolt heads because it offers better grip and less chance of rounding off the bolt head when excess torque is used.
- A deep-well 12-point socket is used to turn nuts when a bolt or stud protrudes through the nut enough to prohibit the use of the shallow socket.

- A deep-well 6-point socket is used in the same situation as described above. It is particularly useful when there is a risk of rounding off tight nuts.

Swivel sockets, or **universal sockets**, have a universal joint built into the socket drive end that allows bolts and nuts to be turned when it is not possible to get straight onto the head.



Impact sockets are designed to withstand the great torque and impact delivered by air impact tools. An impact socket has thicker construction than a standard socket. Note that impact sockets that are used for pneumatic tools are black and not chrome - using a chrome socket with a pneumatic tool might damage the tool and could potentially be unsafe for the mechanic.

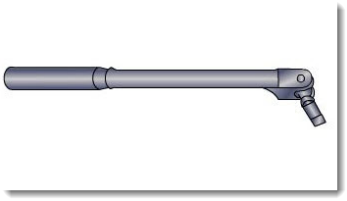


CAUTION: Do not use standard sockets on air impact guns because the socket may shatter.

Bars and handles are used to turn the sockets. The drive end is square and available in 1/4-in, 3/8-in, 1/2-in, and 3/4-in sizes.

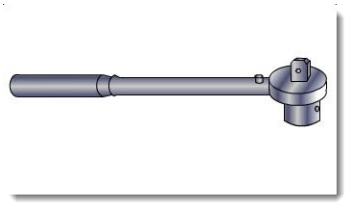
Note: The 3/4-in size is used for large, heavy-duty bolts that are found in trucks. The 1/2-in size is used on large automotive bolts. The 3/8-in size is the most commonly used by technicians. For very small work, the 1/4-in size is used because of its compactness.

The **breaker bar** is a sturdy handle that is used when great torque is required to loosen bolts and nuts. The end of the breaker bar can swing to allow clearance.



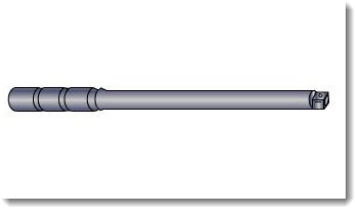
Note: The length of the handle on the breaker bar provides superior leverage for tight nuts and bolts.

The **ratchet** is the most commonly used handle for turning sockets. By rotating back and forth, the ratchet turns nuts and bolts in areas of limited access without being removed after each partial turn.

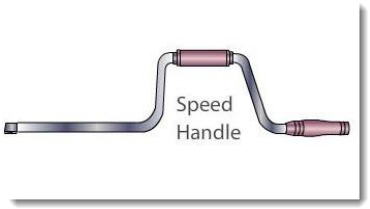


The ratchet is not intended for use under extreme torque because the teeth on the ratchet mechanism may strip. Some ratchets have heads that swivel, which allows clearance while turning.

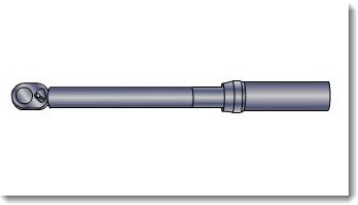
Extension bars aid in reaching recessed bolts and nuts by extending the ratchet drive end. Common extension lengths include 3 in, 6 in, and 12 in. Many other lengths are also available.



Speed handles and T-handles are occasionally used to speed assembly. One advantage of these handles is they do not place side stress on the extension and socket. These handles are not used for the final tightening.



A **torque wrench** is a special handle that indicates the amount of twisting force (torque) that is being applied in tightening a bolt.



A torque wrench is necessary when the torque of bolts must meet manufacturer's specifications. Some models have a scale or dial to indicate torque. Others click or release momentarily when the preset torque is reached. Most recently, electronic versions are available that have easily programmable and accessible torque settings and indicate torque by vibrating, producing an audible signal, and providing a digital display.

Note: Specifications for the torque of bolts are extremely important. If too much torque is applied, the surfaces being joined or the bolt/nut will be damaged. If too little torque is applied, the bolt may work loose.

Occasionally, the technician must use a **socket adapter** on a socket to ease bolt removal.

Note: The **torque capacity** of the socket and ratchet must be considered so that the tool is not damaged or broken.

A size adapter allows the technician to use a different drive size socket on the ratchet or torque wrench.

Note: Care must be exercised when adapting large breaker bars down to smaller drive sockets because the torque capacity of the small socket may be exceeded.

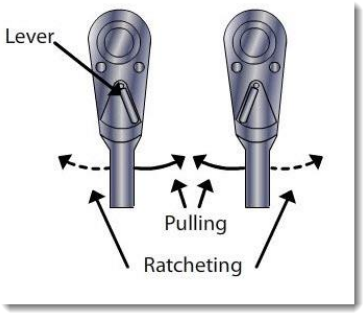
A universal adapter operates best when a socket has limited access that prevents the ratchet and extension from engaging straight onto the socket. These adapters cannot withstand great amounts of torque.

Maintenance

- Sockets and handles should be kept free of dirt and grease and stored in a dry place to avoid rust.
- Ratchet handles can become worn and should be reconditioned if the ratchet starts to slip.

Safety

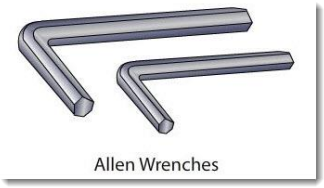
- Ratchet handles can turn both counterclockwise and clockwise and the lever that switches the direction should be firmly and fully placed into its proper position.
- Do not use a ratchet handle as a hammer or pry bar.
- The exact size socket must always be used. Damaged sockets should be discarded, because they can slip off a bolt.



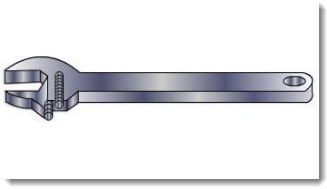
- When using a socket on a damaged bolt head, be especially careful so the wrench does not slip off and cause an injury to the knuckle or hand.
- Always be sure the socket is completely over the bolt head. If the bolt head is so damaged that the socket cannot fit completely over the head, use another method of removal.

Other Wrenches

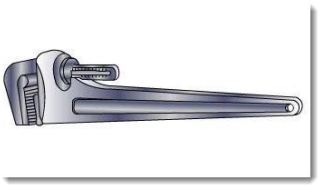
An **Allen wrench** is used on hex head fasteners, which contain a cavity with six sides. A torx wrench is used on torx bolts, which contain a cavity of six rounded points. This design reduces the risk of stripping or disengaging the threads of small fasteners.


Allen Wrenches

An **adjustable wrench** has a screw that allows the jaw to adjust to different sizes. Under normal circumstances, technicians do not use an adjustable wrench for turning nuts and bolts. It has the disadvantage of not gripping as solidly as box-end wrenches, and unless properly adjusted and in good condition, may not grip as solidly as open-end wrenches. An adjustable wrench may be used if the technician does not have immediate access to the proper wrench and if torque requirements are not too high.



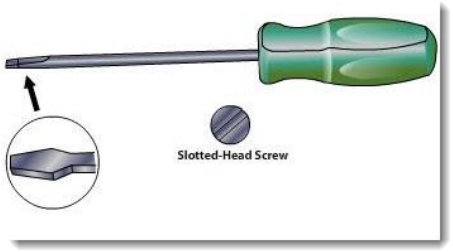
Standard wrenches cannot be used on pipes because of the round shape of pipes. The pipe wrench has teeth that dig in as the wrench turns the pipe. The risk of scarring the pipe can be reduced by placing a leather strap between the pipe and the wrench teeth.



Screwdrivers

Types of Screwdrivers

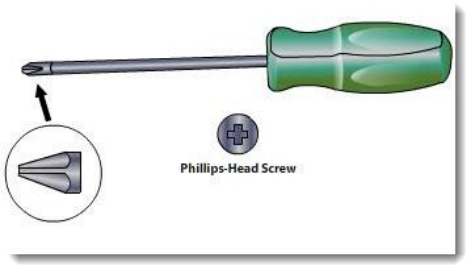
The **standard screwdriver** has a straight blade for turning screws with a slot that is the same width and length as the screwdriver blade.



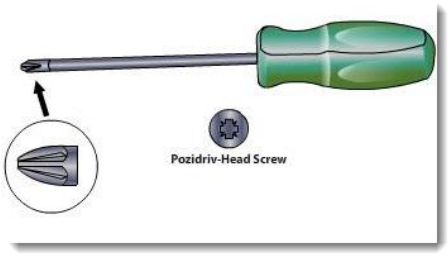
CAUTION: The standard screwdriver is not intended for use as a pry bar, chisel, or gasket scraper. These misuses of the screwdriver can damage the tool and

injure the technician.

The **Phillips screwdriver** fits the crossed slot of a Phillips screw. One advantage this screwdriver has over the standard one is when it is inserted in the slot, it is self-centering. Phillips screwdrivers are available in various tip sizes (e.g., #0, #1, #2, #3, #4) with the lower number being the smallest. A technician should not attempt to use a standard screwdriver to turn a Phillips screw. A good deal of pressure must be applied when using a Phillips screwdriver or the tip may disengage the slot, damaging the screw or the tool. If the slot of a Phillips screw is stripped, it will have to be drilled out.

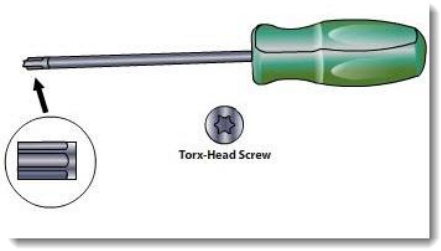


The **Pozidriv screwdriver** is similar to the Phillips in that it is used on a cross-slotted screw. However, the Pozidriv screwdriver and screw head have four additional points of contact.



More torque can be applied with the Pozidriv screwdriver because the blade will not slip out of the screw head as easily as the Phillips screwdriver will. Although not recommended because of improper fit, a Phillips screwdriver will turn a Pozidriv screw. A Pozidriv screwdriver, however, will not turn a Phillips screw.

The **torx screwdriver** has a 6-point tip that is used on torx-head screws.



Nut drivers have a handle and shaft like a screwdriver but have a socket at the end of the shaft that is not removable. Because nut drivers can be operated with greater speed than socket wrenches, they are ideal for loosening and tightening the small nuts and bolts found on vehicles.

Maintenance

- Keep screwdrivers free of dirt and grease and store them in a dry place to prevent rust.
- Keep the heads in good condition and free from nicks.

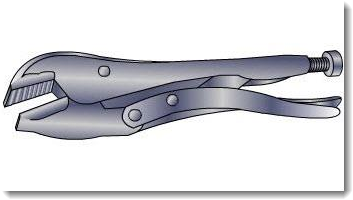
Safety

- The right size screwdriver should be used for each job. The screwdriver should be the right length for access to leverage. The head of the screwdriver should match the head of the screw (both type and size of the screw).
- Do not try to use another tool, such as locking pliers, to grab the handle of the screwdriver and get more leverage. If it cannot be turned by hand, another tool is needed.
- Use screwdrivers with insulated handles to prevent electric shock.
- Do not use a screwdriver as a punch or chisel.

Pliers

Standard slip-joint pliers are one of the most common types of pliers used by technicians. These grip irregular parts and hold work during drilling.

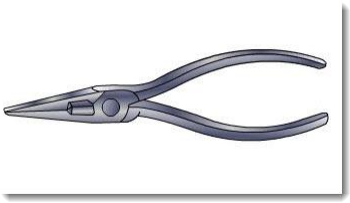
Locking pliers are very similar to standard slip-joint pliers. By turning a knob and then clamping the handles in place, the locking pliers hold work securely.



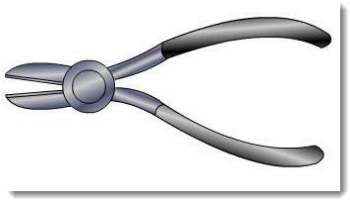
CAUTION: When clamping or removing locking pliers, keep a proper grip on the handles. The handles snap together and snap apart with considerable force.

Adjustable-joint pliers have a long slot with a wide variety of adjustment positions. The offset jaws of the adjustable-joint pliers offer a reach advantage.

Long-nose pliers, or needle-nose pliers, are useful for gripping tiny pins and parts during the service of carburetors and other small assemblies.



Diagonal-cutting pliers are used to cut electrical wire and tape as well as a variety of other material. Diagonal-cutting pliers are well-suited for removing cotter pins on front-end components.



CAUTION: Do not use on live electrical circuits.
CAUTION: Do not cut spring steel with diagonal-cutting pliers because the pliers will be nicked and ruined.

Snap-ring pliers come in many styles and types. Snap-ring pliers are required for spreading or compressing springy snap rings found in transmissions. Snap-ring pliers are available that can remove internal snap rings, external snap rings, or both

Maintenance

- Pliers should be kept free of dirt and grease and stored in a dry place to prevent rust.
- If the jaws of the pliers are held by a screw, the screw should be kept snug.

Safety

- When working near electrical equipment, use pliers with insulated handles.
- Do not use pliers as a hammer.
- Do not hammer on the handles.

Hammers

CAUTION: Wear protective eyewear at all times when using a hammer, punch, or chisel to protect the eyes from flying metal chips. Never strike one hammer with another, because hammer heads are very brittle and metal chips can fly off.

The **ball peen hammer** is the most common hammer used for driving punches and chisels. It has a domed head on one side and a flat head on the other.

A **hand-held sledgehammer** can be used when a great deal of driving power is required.

A **soft-faced hammer** can be used to avoid damage to the work being driven. The head can be made of brass, bronze, rubber, or rawhide as these materials do minimal damage to iron and steel components.

A **plastic-tip hammer** is used when light driving power is needed and a brass hammer could cause damage.

CAUTION: Do not use this hammer to drive punches and chisels. It will destroy the plastic tip.

A **rubber mallet** is useful for installing wheel covers. Always strike the wheel cover evenly around the perimeter.

Maintenance

- Hammers should be kept free of dirt and grease, with the faces smooth and free of all foreign matter.
- Hammers should be stored in a dry place to prevent rust.

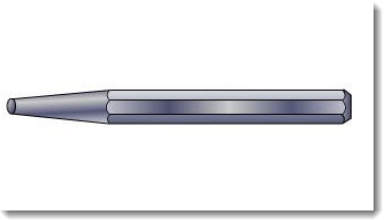
Safety

- Always be sure the head is secured firmly on the handle.
- Be sure the handle is in good condition.
- Strike a flat-surfaced hammer flat against the object being struck, not at an angle.

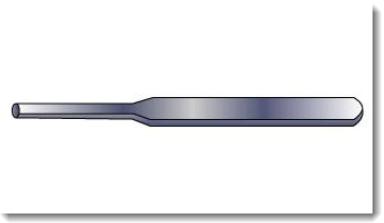
Punches and Chisels

Punches

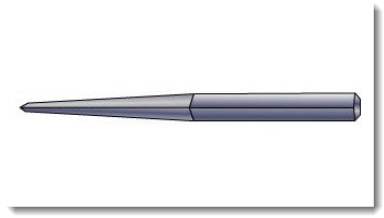
A **taper punch** or **starting punch** is the most commonly used punch. This punch is designed to drive out rivets after the heads have been removed. It is also used to punch out straight and tapered pins.



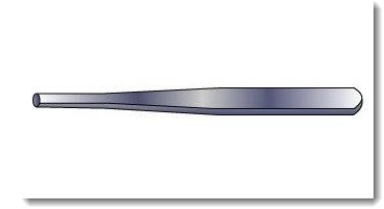
A **pin punch** is used when a small roll pin must be driven through a hole.



The **center punch** is used to make a small dimple in metal prior to drilling. This mark helps ensure that the hole will be drilled in the proper place and that the drill bit will not move.

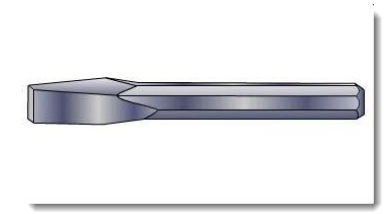


A **brass punch** or **bronze punch** is used when in an area where flammable liquid or gasoline is present. This ensures that no sparks will be created.

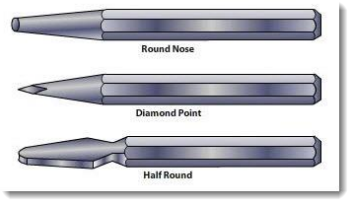


Chisels

The **standard cold chisel** is used to cut and remove metal. The end of the chisel should be ground to a sharp point on a 60° angle.



Different chisel shapes are available for particular jobs. The shapes include the round nose, diamond point, and half round. These chisels are used to cut or chip metal.



Maintenance

- When the head of the punch or chisel mushrooms, the mushrooming must be ground off with a grinding wheel.
- When the cutting edge of the punch or chisel becomes dull and chipped, it must be sharpened with a grinding wheel.
- After a certain amount of maintenance with the grinding wheel, the punch or chisel becomes too short or the edge becomes too blunt. When this happens, it should be discarded.
- Punches and chisels should be kept free of dirt and grease and should be stored in a dry place to prevent rust.

Safety

- Always wear heavy gloves and safety glasses when working with punches and chisels.
- Grind down a mushroomed head immediately. The mushroomed metal may fly off and cause injury. Also, the hammer slips off of a mushroomed head more easily.
- Punches should be tapped gently rather than with brute force. Usually several light hits on the head work better for all purposes than a heavy hit.
- Use a chisel holder to minimize the risk of missing the chisel and hitting a hand.

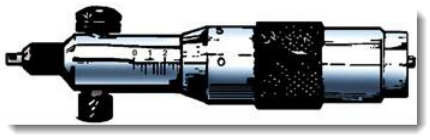
Measuring Tools

Types and Uses of Common Measuring Tools

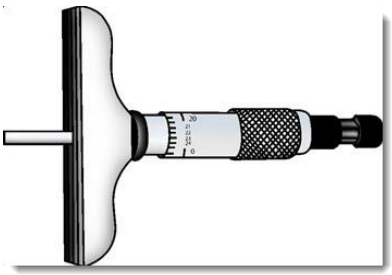
Note: Some vehicle components, particularly in the engine and transmission, contain precision-machined parts that require precise measurements for inspection or replacement.

The **outside micrometer** is used when an outside measurement must be accurate to .001 in or less. Parts requiring these measurements include crankshafts, pistons, valves, and camshafts.

The **inside micrometer** is used when a measurement of the diameter of a hole must be accurate to less than .001 in. Examples of such holes are cylinder bores and main bearing bores.

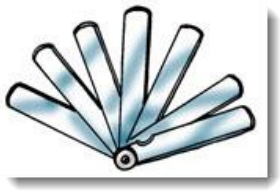


The **depth micrometer** makes precise depth measurements of holes or cavities. For example, it can be used to measure the distance from the center of the crankshaft to the top of the engine block (deck height) and the distance from the top of the piston to the top of the engine block (piston deck clearance).

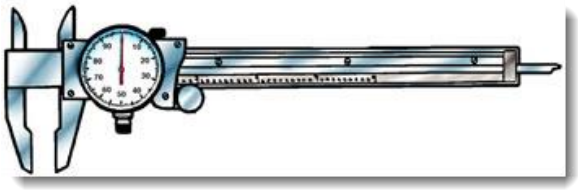


The **dial indicator** tool measures thrust, back-and-forth movement, and runout (side-to-side play). These measurements are made on valves, crankshafts, and flywheels. The dial indicator can also measure the backlash or movement between gear teeth.

A **feeler gauge** measures air gaps and clearance between moving parts and has numerous flat leaves of different specific thicknesses.



A **dial caliper** is used for inside, outside, and depth measurements. One application is measuring bolts and small machined parts.



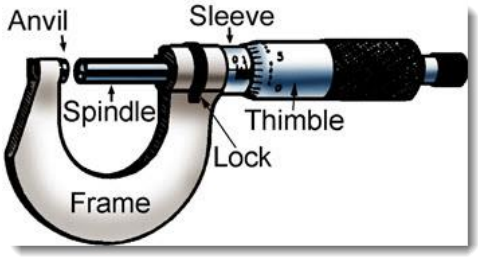
Plastigage is a tiny strip of clay-like material that measures clearances such as between engine bearings and their journals and main bearings and connecting rod bearings. The strips are color coded according to the clearance range.

Procedures for the Use and Care of Measuring Tools

CAUTION: The proper care and use of precision measuring tools are critical to the accuracy and long life of the tool. An incorrect measurement can result in expensive component failure.

Using an outside micrometer

Before using an outside micrometer, become familiar with its parts.



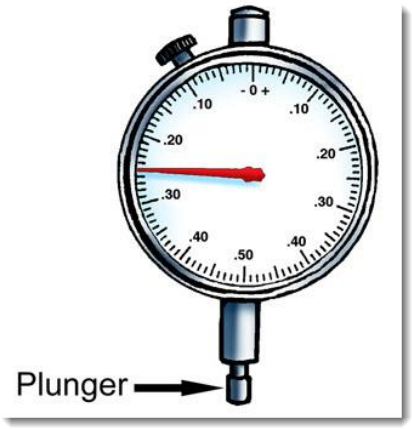
Note: The outside micrometer does not readily display the measurement. Some addition is required in order to arrive at the micrometer reading. The technician must develop a feel for the outside micrometer in order to achieve accurate results.

- Place the object to be measured between the anvil and spindle and turn the thimble until the object is lightly contacted by the anvil and spindle. Lock the spindle and remove the micrometer from the object.
- Read the number indicated on the micrometer sleeve (upper scale). Each number represents one tenth (.100) of an inch.
- Add 25 thousandths (.025) of an inch for each additional line showing on the sleeve (lower scale) past the number.
- Add the number of thousandths (.001) of an inch indicated on the thimble.
- Add the number of inches of the minimum dimension that the micrometer can read 0 in through 5 in.

Reading an inside micrometer and depth micrometer is similar to reading an outside micrometer. Be sure to add the correct figure for the minimum measurement.

Using a dial indicator

- Securely attach the dial indicator so it will not move and give inaccurate readings. The dial indicator is positioned with a clamp-on base or with a magnetic base.
- Position the plunger against the part being measured.
- Rotate the indicator until the needle is on zero. If making a thrust measurement, the shaft or gear that is to be measured must first be pried one way.
- Rotate the part for runout measurements or pry the gear or shaft for thrust measurements, and note the reading in thousandths of an inch on the dial.



Using a feeler gauge

- Select a sample leaf and make a trial fit between the two surfaces.

Note: The thickness of the leaf is printed on the leaf.

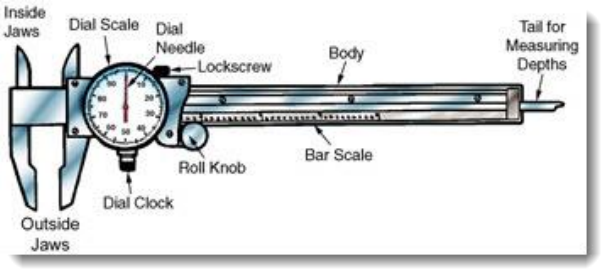
- If the leaf is too loose or too tight, try another leaf.
- When there is a slight, smooth drag as the feeler gauge is removed, the correct leaf has been found. The size printed on the feeler gauge is the clearance.
- After use, put a little oil on the leaves to prevent rust.

Using a dial caliper

Note: A dial caliper is accurate to approximately + or - 0.002 in. When more precision is required, use a micrometer.

Before using a dial caliper, become familiar with its parts.

- Adjust the dial caliper with the roll knob until the jaws lightly contact the work.
- Read the measurement on the linear scale and add the reading on the dial.



Using Plastigage

- Select a small piece of Plastigage material.
- Place the Plastigage material on the crankshaft journal. The Plastigage piece must span the full width of the journal and be centered with the bearing cap.
- Install the bearing cap and tighten to the proper torque.
- Remove the bearing cap and inspect the Plastigage. It should appear somewhat smashed. Compare the width to the paper gauge on the Plastigage package.

Care of measuring tools

- Adjust precision measuring tools carefully. For example, only very slight pressure is needed to tighten the thimble on a micrometer. Overtightening can destroy the adjustment.
- Do not attempt to adjust measuring tools with the lock on.
- Always store measuring tools in their case or in a safe place to protect them from damage, grease, dirt, and moisture.
- Check the calibration of precision measuring tools frequently. Consult the manufacturer's instructions for the proper procedure.

Chapter 2: Power Tools

Electric Tools

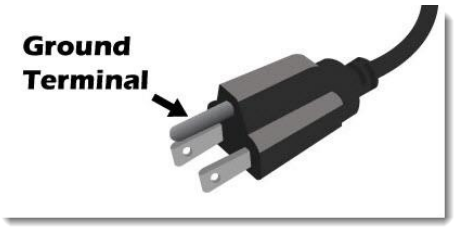
Electric tools are driven by an electric motor. Using electrical equipment is a matter of common sense and using good safety practices.

Note: Electric hand tools are still in use in shops, but some have been replaced by pneumatic (air-operated) equipment, which is usually lighter.

Safety

- As with any electrical devices, be aware of the dangers of electric shock.
- Do not stand on wet ground or a wet surface when operating an electric tool.
- Always check that the power cord will not be damaged by the operation of the equipment and do not run over power cords with any heavy object.
- Always check that the power cord is not frayed or worn.

- All electric tools must have a three-pronged plug unless the tool is double insulated. Double-insulated tools cannot short to the outside case and require only a two-prong plug.



- Do not eliminate the ground terminal of a three-prong plug by using an adapter or clipping the terminal.
- Do not put cords in water or across moving machinery.
- Wrap up cords carefully after use and store them properly.
- Keep hands and clothing away from the moving parts of electrical equipment.
- When inspecting or making adjustments to electric tools, always disconnect them from the power supply.

Maintenance

- Check the service manual for the equipment being used.
- Electrical equipment should be kept free of dirt and grease and should be stored in an area that is dry and free of dust.

Cordless tools

These tools use a battery cell as the power supply, instead of electricity from a wall outlet. They are convenient in shops due to portability and the absence of power cords; however, frequent recharging is necessary.

Safety

- Always disconnect a cordless tool from its battery before inspecting it and making adjustments to it.
- Use only the battery specified by the manufacturer for the tool being used.
- Always store battery packs safely so that no metal can come in contact with the terminals. Contacting the terminal can short-circuit the battery and cause sparks, fire, or burns.

Pneumatic Tools

Pneumatic tools are powered by compressed air. Pneumatic tools have advantages over electric tools. They are lighter and, unlike electric tools, are not damaged by overloading or stalling. Although there are dangers associated with compressed air, the dangers are not as great as those associated with electricity.

Safety

- Operate air tools only for their intended purpose.
- Air impact guns, air hammers, and air drills can create flying metal chips that are dangerous to the eyes. Wear protective eyewear at all times when working with or around air tools.

CAUTION: Wear personal protective equipment (PPE) when flying metal chips are possible.

- Pneumatic tools produce a great deal of power. Using an improper attachment or placing the attachment on the tool incorrectly can result in breakage. Use only impact sockets on air impact guns.
- Water and oil can accumulate in air compressors. These should be drained daily. It is possible for compressed air to carry infection even with daily draining.

CAUTION: Do not play with compressed air blowguns or hoses. The high-pressure air stream on the skin can cause severe infection, require the amputation of a limb, and cause death.

- Pneumatic tools create a great deal of noise. Wear ear plugs, ear muffs, or other types of ear protection.
- Do not look into the air-outlet valve or nozzle on any piece of air-powered equipment.
- Do not grab the movable portion of an air-powered tool with the hand when it is hooked up to the air line.
- When inspecting or making adjustments to pneumatic tools, always disconnect them from the air supply.

Maintenance

- Before any new air tool is used, three or four squirts of air tool oil should be applied to the air inlet to flush any dirt or moisture from the rotor and to lubricate the moving parts. Do not use air tool oil around an open flame as it is highly flammable.
- Oil pneumatic tools regularly according to manufacturer recommendations.
- Pneumatic equipment should be kept free of dirt and grease and should be stored in an area that is dry and free of dust.
- Care should be taken that no foreign matter enters the nipple opening of the couplings on pneumatic equipment.

Basic designs of pneumatic tools

Rotary — The air drives a rotor (turbine) that spins a shaft and provides the power.

Reciprocating — The air drives a piston that is forced back and forth by the compressed air.

Note: The exceptions to the above two kinds are blowguns and paint-spraying equipment, which use a direct stream of air.

Pneumatic couplings

Pneumatic equipment is connected to air supply equipment through quick couplers. The quick coupler is on the end of the air supply hose and connects into a nipple on the equipment. On some tools, the manufacturer recommends attaching a short leader hose to the tool and installing the nipple at the end of the leader hose. The quick coupler operates by pulling back a collar on the coupler, which allows the nipple to be inserted into the coupler. When the collar is released, it locks the nipple into the coupler.

Hydraulic Tools

Note: Most hydraulic tools fit in the category of shop equipment, which is discussed in the next lesson.

Hydraulic tools use pressurized fluid within a cylinder to create great pressure. The fluid is **hydraulic fluid**, a petroleum product that is much like oil. The hydraulic pressure within the tool is created by air pressure or the manual pumping of a handle. Common hydraulic tools and equipment used in the shop include jacks, lifts, hoists, and presses.

Safety

- Before operating a hydraulic tool, inspect its parts to make sure none are damaged or deteriorated.
- Keep hydraulic hoses away from potential damage such as grease, oil, sharp objects, and hot surfaces.
- Before using a hydraulic tool, consult the manufacturer's information to be sure it is appropriate for the task and that the task will not exceed the tool's load limit.
- Check hydraulic tools frequently for leaks. Leaks can cause the tool to fail, with dangerous results.

Maintenance

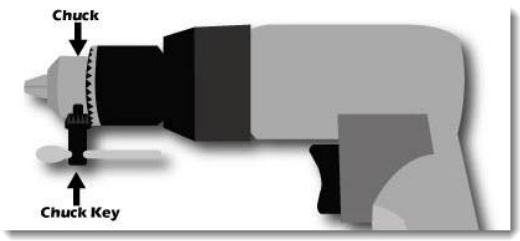
- Check the service manual for the tool being used.
- Inspect tool components and report any damage, leaks, or deterioration to the instructor.

Power Drills

Electric drills can be used interchangeably with pneumatic drills. Drills are used with drill bits to drill holes or with special attachments to remove rust or gasket material.

Pictured here is a Cordless Drill, an Electric Drill (note the cord) and a Pneumatic Drill.

Electric drills use an electric motor to drive a **chuck**, a device that holds the drill bit in place and aligns it properly. Pneumatic tools use a rotor, which drives the chuck. A **chuck key** is used to loosen and tighten the chuck. Drills are also available with keyless chucks.



The size of the drill is determined by the maximum diameter of the drill bit shaft that the chuck holds. For example, a 1/4-in drill holds a drill bit with a shaft diameter no larger than 1/4 in. The most popular sizes are 1/4 in, 3/8 in, and 1/2 in.

Drill bits

Drill bits come in various sizes and lengths and are interchangeable between electric and pneumatic drills. When looking for a particular size of drill bit, use a drill gauge. Drill bits are made of high-grade steel and, if used properly, they seldom need sharpening. Drill bits are sized according to the size of hole they drill. Do not use metric drills in place of United States Customary System (USCS) drills or vice versa. If a 12-mm hole is required, use a 12-mm bit.

Safety for power drills

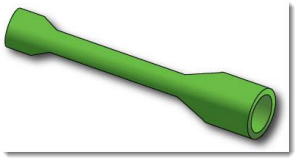
- Make sure the bit is tightly seated in the chuck, securing it by turning the chuck key in each hole. Be sure to remove the chuck key before starting the drill.
- Make sure the work is firmly secured before starting to drill.
- Keep a firm grip on the drill and be ready to shut it off if it jams. Drills often jam just as they are about to penetrate what they are cutting.
- If an electric drill jams, turn the drill off and pull it back out, then start it and continue to drill the hole. The same procedure should be performed for restarting a pneumatic drill. Such jamming may damage an electric drill.
- Remove the bit from the drill when the work is completed.

Power Wrenches

Impact wrench

Impact wrenches can be either pneumatic or electric and are used to drive impact sockets to loosen or tighten nuts and bolts. They use sockets that are specially made to have greater strength than standard sockets.

The **wheel torque socket**, also called a torque stick, is a type of socket commonly used with impact wrenches. **Torque sticks** are long-shafted sockets that work in combination with an impact wrench to install lug nuts on wheels. They are designed to flex when the proper torque is reached, helping to prevent the damage that can result from overtorquing. The sticks are color coded per socket diameter and torque limit.



CAUTION: Torque sticks are designed for tightening lug nuts, not loosening them; using torque sticks to loosen lug nuts will damage the sticks.

Using impact wrenches

- A built-in regulator allows for adjustments in speed and torque. However, do not rely on the regulator to adjust the amount of torque accurately. Final tightening should be done with a torque wrench.
- Hold the wrench with a slight forward pressure on the bolt or nut.
- Soak rusty bolts and nuts with penetrating oil before using an impact wrench to loosen them.
- A switch can change the impact wrench from counterclockwise to clockwise operation.

Air ratchet

The **air ratchet** is a smaller version of the impact wrench and usually uses a 1/4-in or 3/8-in drive lug. It delivers less force than the impact wrench and standard sockets may be used with it. The air ratchet has a switch to change it from clockwise to counterclockwise rotation.

Note: An air ratchet should be used only to snug a bolt. A conventional ratchet or torque wrench should be used to complete the tightening of a bolt.

Air chisel (air hammer)

The **air chisel** uses reciprocating motion to provide rapid impact force, much like a rapid series of short hammer blows. Available attachments include cutters, chisels, and punches. The air chisel is often used to break welds loose, cut rivets, punch holes, and shear sheet metal.

Safety for power wrenches

- Always wear PPE when using power wrenches.
- When operating an impact wrench, only use sockets that are made for impact wrenches. If a standard socket is used, it may break or be damaged and fly off of the tool.
- Be sure that the chisel in the air chisel is firmly secured and that the cutting edge is sharp.

Chapter 3: Shop Equipment

The term "shop equipment" refers to large or expensive pieces of equipment or tools, which are generally provided by the shop owner.

Electrical Equipment

Wheel balancer

Shops equipped to mount tires have a wheel balancer. Many shops now use computerized wheel balancers. Wheel balancers are used to equally distribute weight around the wheel's centerline.

Safety

- Consult the instructor before using the wheel balancer.
- As with any electrical devices, be aware of the dangers of electric shock.
- Do not stand on wet ground or a wet surface when operating electrical equipment.
- Ensure the guards are in place before operating the wheel balancer. Be aware of the rotating mass that could cause injury if contact is made.

Bench grinder

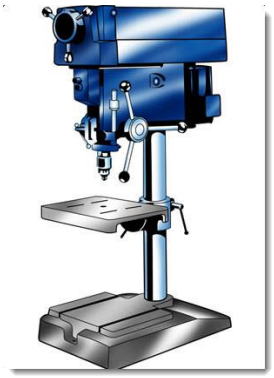
A bench grinder is a common piece of shop equipment. A bench grinder is generally used to maintain tools that have become dull and to grind sharp edges from metal pieces. The grinder is mounted to a bench and is powered by an electric motor. In addition to the grinding wheel, the grinder can be used with a wire wheel that cleans rust and dirt off parts.

Safety

- As with any electrical devices, be aware of the dangers of electric shock.
- Always wear safety glasses and a particle mask when working with a bench grinder. Wear a respirator, as needed, for grinding certain materials.
- Be sure that clothing, hair, and other combustibles in the area are protected from the sparks given off by the grinder.
- The bench grinder should have a tool rest platform in front of each abrasive wheel, in addition to a wheel guard and an eye shield.
- Do not put excessive pressure on the wheel because it could break apart. Do not use wheels that are broken or worn.
- Follow the bench grinder manufacturer's recommendations for removing and replacing grinding wheels. Do not overtighten the spindle nut.
- When grinding small parts, never hold the parts by hand. The parts can be very hot and easily propelled through the air by the wheel. Use standard slip-joint pliers to hold small parts.
- Abrasive wheels are designed for specific types of metals. Do not grind aluminum on grinding wheels designed for steel. Aluminum chips will clog the wheel's surface.

Drill press

Some shops have a drill press for drilling holes in metal parts.



Maintenance

- Inspect bits regularly. Sharp bits cut better and are less likely to break.
- Oil the bit as needed to prevent binding.

Safety

- As with any electrical devices, be aware of the dangers of electric shock.
- A full face shield and protective eyewear should be worn.
- Parts drilled by the press must be securely held by a vise or standard slip-joint pliers. This prevents the work from spinning out of control and cutting hands.
- When using the drill press, do not wear loose clothing or jewelry. Do not allow long hair to hang freely.

Test and service equipment

A variety of electrical test and service equipment can be found in the shop. Each piece of equipment has its unique safety considerations. Consult the instructor before using a new piece of equipment.

General maintenance guidelines for electrical equipment

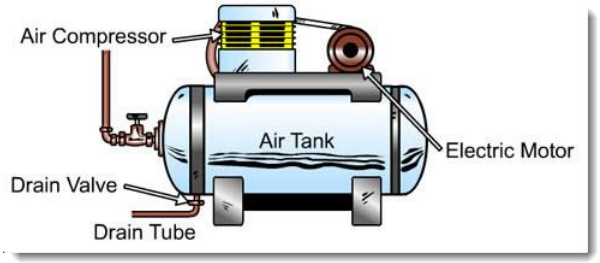
- Check the service manual for the equipment being used.
- Electrical equipment should be kept free of dirt and grease and should be stored in an area that is dry and free of dust.

Pneumatic Equipment

Pneumatic equipment can be permanently attached to the shop air compressor or temporarily attached to the compressor by rubber hoses.

Air compressor

An **air compressor** provides the compressed air needed to operate pneumatic hand tools and equipment in the shop.



Compressors are usually operated by an electric motor and are composed of the following three main parts.

- Motor
- Compressor
- Storage tank

The motor drives a compressor that takes in the air around it, compresses it into a smaller volume (thus increasing pressure), and then stores the compressed air in a large storage tank.

Maintenance

- Check the oil each week and maintain the oil at the proper level.
- Drain water from the tank and check the air-safety valve each day.
- Change the oil, check the belt condition and tension, and clean the air-intake breather per manufacturer's recommendations.

Safety

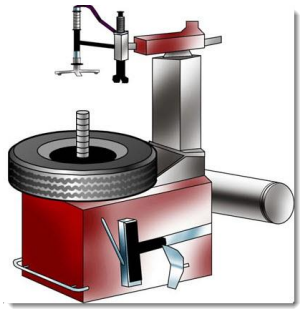
- Always disconnect an air compressor from the power before inspecting or making adjustments to it.
- Before operating an air compressor, inspect its parts to make sure none are damaged.
- Make sure the electrical outlet for the air compressor is properly grounded.
- Water and oil can accumulate in air compressors. These should be drained daily. It is possible for compressed air to carry infection even with daily draining.

CAUTION: Do not play with compressed air blowguns or hoses. The high-pressure air stream on the skin can cause severe infection, require the amputation of a limb, and cause death.

- Air hoses should not be run over with vehicles or equipment and should not be used to pull tools across the shop floor.
- Air hoses should be kept free of grease and oil and neatly coiled for storage at the end of the workday.

Tire machine

The **tire machine** uses great force to manipulate tires. Its uses include removing and reinstalling the tire onto the wheel and inflating the tire to the proper pressure.



Safety

- The tire machine is one of the most dangerous pieces of shop equipment. Do not use the tire machine without proper training.
- Truck tires that use the split rim type of mounting are very dangerous. These must be inflated in a special cage. Consult the instructor before attempting to mount a truck tire or any type of tire.
- Wear protective eyewear when working with a tire machine.

Pneumatic jack

A pneumatic jack can raise a vehicle by the bumper or axle. Special instruction is required to use a pneumatic jack. The vehicle must be lowered onto safety stands before a technician can work under a vehicle supported by a jack.

Safety

- Never work under a vehicle supported only by a jack.
- Consult the instructor and repair manual when placing safety stands for the proper locations of the stands.
- Be sure that the load-capacity rating for the safety stands is sufficient to safely support the vehicle.
- Do not lift vehicles with passengers inside or with the doors, hood, or luggage lid open.

General maintenance guidelines for pneumatic equipment

- Consult the maintenance instructions provided by the equipment manufacturer.
- Keep the piece of equipment free of dirt and grease and store it in an area that is dry and free of dust.
- Care should be taken that no foreign matter enters the nipple opening of the couplings on pneumatic equipment.

Hydraulic Equipment

Hydraulic equipment develops pressure as a result of the closing of a valve and the pumping of a handle or as a result of a combination of air pressure over hydraulic fluid.

Hydraulic floor jack

The **hydraulic floor jack** has a cylinder that raises the front, rear, or side of a vehicle by pumping a handle. A floor jack is mounted on four wheels for portability. It should only be used after thorough instruction. The vehicle must also be supported by safety stands.

Hydraulic press

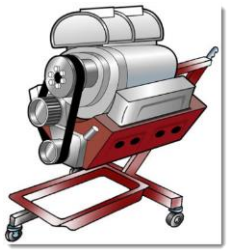
Safety

- Consult the instructor for the procedure for properly setting up and using the hydraulic press.
- Wear personal protective equipment (PPE) while using a hydraulic press.

Engine hoist

The **engine hoist**, or **portable engine crane**, is used to raise heavy engines and transmissions. After turning a valve, a handle is pumped to raise the hoist. A hoist is simply a hydraulic jack that is designed for attaching onto the top of an object and pulling it upward, instead of getting underneath of an object and pushing it upward.

The engine hoist is not intended to support an engine while it is being serviced. The engine should be mounted on an engine stand during service.



Safety

- Consult the instructor before using the engine hoist.
- Stand clear of any object being raised in case the hoist fails or topples, or the object being lifted comes loose.
- When moving an object that is suspended from the crane, move the crane very slowly.
- Do not work on any object while it is suspended from the crane. Lower it to a workbench or the floor (or into an engine stand for a motor).

Hydraulic Lift

A **hydraulic lift** raises the entire vehicle off the ground. Most lifts use air pressure to pressurize hydraulic fluid, which is then pumped into one or more large cylinders.

Vehicle Lifting

As a technician, you will repeatedly find yourself working underneath a vehicle. Lifting technology enables you to raise the vehicle up, providing the mobility and clearance you need to work. Like all tools and machinery in the shop, lifts and jacks should only be used in accordance with their capacity and function. Using improper lifts and makeshift jacks is a life-threatening risk.

Lifting a full car is best accomplished by a full car lift, but floor jacks and axle stands can do the job as well.

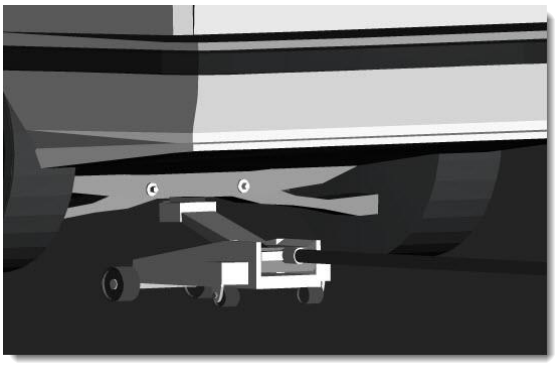
Axle Stands and Jacks

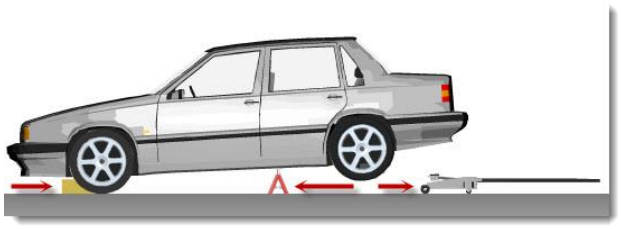
All lifting machinery will have a clearly designated weight capacity. Technicians should learn the capacities of the shop's jacks and lifts. It is important not to exceed these capacities.

Vehicles have safe points for jacking—if these are not used, both you and the vehicle are in danger. Aside from the obvious danger of the improperly supported vehicle dropping on you, the jacks can puncture more fragile points on the underside of the car. The jack should never lift at the floor plans, driveshafts, steering arms, or crankshaft pulleys. No jack should come in contact with the axle unless lifting pads are in place. These pads reduce slippage between the axle and the jack.

When lifting a vehicle, it is important to follow all safe steps carefully. The weight of a car can cause serious injuries in a fall. When using a jack, remember the following steps:

- Make sure the parking brake is engaged.
- The jack should be situated beneath a secure lift point.
- Jack stands should be put into place to support the weight of the vehicle. Be sure you are familiar with the safe places to lift or stabilize a vehicle.
- After the vehicle is supported on one end, block the wheels on the end opposite the jack. This helps prevent the vehicle from rolling.
- Jack lever should remain in an upright position while the vehicle is raised. This will reduce the risk of passing technicians tripping and releasing the valves.





When raising a vehicle with a complete lift,

- The vehicle should be situated upon the lift with its center of gravity either between the lift pads on the frame contact lifts or near the center of the lift.
- The lift pads should be positioned at the vehicle’s designated lift points.
- If the lift has retractable arms, they should be completely extended.

- Block the wheels prior to lifting to ensure the vehicle does not roll.
- Lift slightly to make sure the vehicle is secure and in place. If so, the vehicle can then be lifted completely.

Jacks should be in correct working order before using-never use leaking or slipping jacks. Hydraulic jacks should be checked for leaks. Fluid should be maintained at manufacturer's standards.

Never expect a jack alone to hold a vehicle. A jack stand should always be used in conjunction with any jack. This secondary support must be raised to the same height as the jack. The jack handle should be positioned upright when the vehicle is raised. This reduces the risk of other technicians tripping over the handle and releasing the shut-off valve.

Before any vehicle is lifted, its wheels should be secured. Block the wheels opposite the side of the jack. Activating the parking brake will provide additional safety when the vehicle is raised. Lifting jacks should be used only on a level surface.

General maintenance guidelines for hydraulic equipment

- Consult the maintenance instructions provided by the equipment manufacturer.
- Inspect equipment components and report any damage, leaks, or deterioration to the instructor.

Unit 5: Vehicle Service Preparation

Chapter 1: Vehicle Service and Customer Service

Proper Customer Relation Procedures

Note: Studies have shown that more people are fired for their inability to get along with others than for a lack of technical expertise. The behavior of the technician and other workers can jeopardize the financial stability of the shop.

Note: The amount and degree of customer contact required in an automotive technician position will vary depending on shop organization and policy.

All employees in the shop should greet the customer when appropriate and act in a friendly, courteous manner. Refer to the customer by using "Mr." or "Ms." and the person's surname.

Listen carefully and patiently. After the customer has explained the problem, ask questions that may help in the diagnosis. Keep in mind that people communicate at different paces and in different styles.

Note: The customer is likely to be upset that the vehicle he or she depends on is unavailable and that the repair may be expensive.

- It is important to verify the complaint. Some customers unknowingly give a false diagnosis.
- Give the customer an estimate. A customer will likely be very upset if presented with a large repair bill that was not expected. Obtain the customer's phone number and call the customer before beginning the repairs.
- Look for potential problems other than those described by the customer. Explain any new problems to the customer in a professional manner.

Note: In most shops, the service manager/writer usually has the responsibility of calling the customer.

- Perform the repair in a professional manner. Remember that the customer is paying for a repair. The outcome of the job performed makes a statement to the customer and employer about the technician's skills and professionalism.
- Verify the repair. One of the most common complaints of vehicle owners is that they paid to have a repair performed only to experience the same problem after the repair was to have been made.

Preparing a Vehicle Before and After Service

Another important part of customer service is making sure each customer's vehicle stays clean and free of damage during its time in the shop.

Place **fender covers** on the fenders, front grille, and other areas as needed to protect the vehicle from grease, scratches, and dents.

Use **floor protectors** to ensure dirt and grease from technicians' shoes do not soil the carpet.

Use **seat covers** to ensure that dirty or greasy hands and clothing do not soil the seats.

Cover the steering wheel with a **steering wheel cover** to protect it from greasy hands and fingerprints.

After service, follow the shop's policy on preparing the vehicle to return it to the customer. Some shops may require that all protective covers are removed, whereas others may want covers such as the floor protectors left in. Ensure that the customer's vehicle is as clean as when he or she dropped it off. Clean off any dirt or grease that may have gotten on the vehicle's exterior or interior.

Functions and Components of a Work Order

The automotive technician should be familiar with the functions and components of a work order.

The work order serves several functions:

- Itemizes the repairs by listing the cost of parts and labor
- Can be used to authorize the repair
- Has the necessary information on how to contact the owner and serves as documentation for future reference
- May also specify limited warranties and liabilities of the shop
- May serve as a reference for recent service history for warranty or legal purposes

A work order typically has the following components:

- Customer name, address, and phone number (home or work with extension number)
- Date
- Invoice number
- Year, make, model, vehicle identification number (VIN), and mileage of the vehicle
- Name/initials of the service writer and technician
- Customer authorization signature to allow repairs
- Description of customer concern
- Vehicle service history information
- Related technical service bulletins (TSBs)
- Technician's notes that includes diagnostic procedures performed, the results of diagnosis, and any important observations or remarks
- Component or system defect responsible for the concern
- Service performed to successfully correct the concern
- Labor procedures and costs based on the parts and labor estimation guides
- Outside labor procedures and costs that include if a shop sent a particular part out to another shop for repairs
- Listing of each part that includes name, description, and cost
- Sales tax, which is usually calculated on parts only

- Total that represents the final price that the customer will pay for all charges related to the repair

Note: View a sample work order via the Today's Class course MLR: Service and Safety, Unit 5, Chapter 1, on the Work Orders tab.

Work orders may be handwritten or prepared by entering codes in a computer terminal and then printed.

- Depending on the part, the following information may be required for ordering repair parts.
- Make, model, and model year (found on the driver's side door jamb) of the vehicle
- VIN
- Engine information that includes engine size, in cubic inches or liters, the number of cylinders, and the type of fuel system
- Wheelbase
- Number of doors

Diagnosing a Vehicle Problem

Use the three Cs (***concern***, ***cause***, and ***correction***) to diagnose the vehicle problem. Identify the concern. If possible, ask the owner/driver the following questions.

- Under what conditions does the problem occur?
- Are there unusual sounds?
- How long has the problem existed? Is it getting worse?

Test drive the vehicle under the conditions that the problem has been observed.

CAUTION: Always obtain instructor's approval before conducting a road test. Conduct the road test in an area with little or no traffic. Never exceed the legal speed limit during the road test. Always wear safety belts. An assistant should record all observations made during the road test. Do not attempt to drive and record results at the same time.

Isolate the cause of the problem.

Locate and interpret vehicle and major component identification numbers.

- VIN
- Vehicle certification labels
- Calibration decals
-

Research applicable vehicle and service information.

- Applicable components and their operation
- Vehicle service history
- Service precautions
- Technical service bulletins

Perform a visual inspection of the applicable system.

- Look for damaged or broken components.
- Look for worn or misaligned components.
- Check fluid levels.
- Inspect related electrical sensors, corrector, controls, and wiring.

Test the systems and components that could cause the problem. Eliminate good components until the cause is found.

Determine the necessary action and correct the problem.

Vehicle Service Information

Sources

Note: Vehicles have become so technologically advanced that service information is used on every job. This information contains diagnosis procedures, specifications, and service procedures. Technicians must know how to locate and use the information that is available.

Vehicle manufacturers publish service information for each model year of the vehicles they manufacture. This service information is the most comprehensive and the best source of information for a specific vehicle. It includes vehicle specifications, diagnostic and repair procedures, parts diagrams, and special tools required. Because many technical changes occur after the service information is published, manufacturers provide **technical service bulletins** (**TSB**s) to update the information. The information in the TSBs also appears in the next edition of the service information.

Professional general service manuals are used by independent repair shops because one manual can contain information for many domestic or foreign cars produced over several years. These books summarize the most important information and do not include all the specifics.

Aftermarket specialty manuals are often sold at bookstores and may cover one model of vehicle produced over several years. These manuals are written for individuals with and without experience in the automotive repair profession and are popular with the "do-it-yourself" individual.

An **owner's manual**, prepared by the vehicle manufacturer, is provided to the purchaser of the vehicle and is usually stored in the glove compartment. It includes basic information about the location and function of vehicle accessories, starting the vehicle, and maintaining the vehicle.

Sites on the Internet are available to find information that a shop may not have in its library, such as more up-to-date information, recall information, or information about a hard-to-diagnose repair issue.

Formats

Besides printed manuals, service information is available for use on computer hard drives, networks, and CD-ROMs.

Using computerized information rather than printed materials saves space. In addition, accessing the information on a computer is easier and saves time.

Using the Manufacturer's Service Information

Get familiar with the components of the service information and how they are organized. Doing so will help in finding information quickly. The general information section includes vehicle information such as identification (e.g., reading the **vehicle identification number** (**VIN**) to get data about the vehicle), basic maintenance, and lubrication. The repair sections, which cover each system of the vehicle, have detailed procedures for diagnosing, inspecting, testing, and repairing the systems. These sections also include the following features:

- Illustrations of exploded views of parts or steps in the procedure
- Diagrams showing the layout of hoses or circuits
- Diagnostic or troubleshooting charts for systematically finding the source of a problem

Before performing a procedure, read it through once to get an understanding and overview of what is required. Be careful to do all steps in a procedure and perform them in the correct order. Missing steps or performing them out of order may cause unsuccessful results.

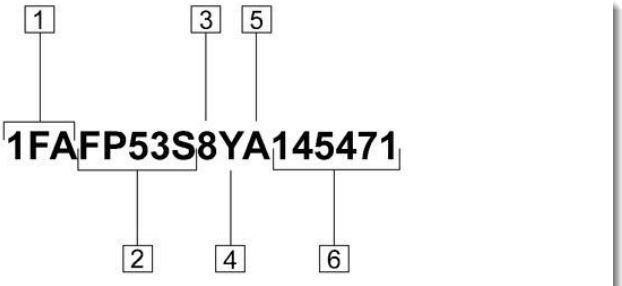
Locating and Reading the Vehicle Codes

In the early 1980s, the National Highway Traffic Safety Administration began requiring vehicle manufacturers to identify each vehicle made for highway use with a **vehicle identification number** (**VIN**). A vehicle's VIN is a code with 17 characters (letters and numbers) that is permanently affixed to the vehicle. The VIN is typically found in several locations on a vehicle. Some of the more common locations are listed below.

- Dashboard near the lower part of the windshield on the driver's side
- Certification label on the driver's door frame
- Engine compartment

The VIN uniquely identifies a vehicle and provides a great deal of information about the vehicle's origin and features. See the sample VIN below for a breakdown of the code.

For help in reading the VIN for a specific vehicle, check the general service information section of the service information for that vehicle.



1 — Country and Manufacturer Identifer
2 — Line, Series, Body Type, Engine Type, Restraint System Type
3 — Check Digit
4 — Model Year
5 — Plant of Manufacture
6 — Production Sequence Number

An engine serial number and identification number or code is generally stamped on the engine block. The exact location of these numbers depends on the manufacturer. Engine codes provide technicians with specifications for the vehicle's engine, such as the horsepower rating and whether the engine was designed for a manual or automatic transmission.

Preparing a Vehicle for a Customer

After service, follow the shop's policy on preparing the vehicle to return it to the customer. Some shops may require that all protective covers are removed, whereas others may want covers such as the floor protectors left in. Ensure that the customer's vehicle is as clean as when he or she dropped it off. Clean off any dirt or grease that may have gotten on the vehicle's exterior or interior.

1. Ensure that the owner's concern has been completely corrected following proper service procedures.
2. Inspect the vehicle to ensure that all bolts, clips, retainers, and covers are in place.
3. Check all fluid levels and inspect for fluid leaks.
4. Check the operation of lights, wipers, and other vehicle accessories.

5. Test drive the vehicle to detect possible concerns with brake system, driveabillity, or steering and suspension concerns.
6. Note all malfunctions on the work order - be sure that the owner is aware of these conditions and has the opportunity to have additional service performed (this is to ensure customer satisfaction, not to upsell services).
7. Return the driver’s seat, steering wheel and mirrors to the position that they were in when the vehicle was received for service.