CHAPTER 13

Vehicle Maintenance Inspection

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

- **13-1** Perform in-vehicle inspection.
- **13-2** Perform fluid inspection.
- **13-3** Perform belt, hose, and air filter/cabin air filter inspection.
- **13-4** Perform under-vehicle inspection.
- **13-5** Perform exterior vehicle inspection.

YOU ARE THE AUTOMOTIVE TECHNICIAN

You work for a car rental company that maintains their vehicles in-house. Your main task today is to perform preventive maintenance on a vehicle in the fleet that is scheduled for its next service. To perform a routine maintenance check, you follow a procedural checklist. That includes changing the oil and filter; rotating the tires; and inspecting the brake, steering, and suspension systems. It also involves checking/inspecting other important parts. During the inspection, you notice that the brake fluid level is low. You also notice that the wiper blades smear badly. Finally, you see that the left rear brake light is not working and requires a bulb replacement.

1. What two conditions can low brake fluid level indicate?
2. How do you determine what engine oil to use?
3. What is done during a tire inspection?
4. How are shock absorbers inspected?
5. How should warning lights react when you start the engine?

Introduction

Vehicles comprise thousands of parts, all of which work together to provide a safe and reliable means of transportation. However, those parts do not last forever. They need periodic inspection to assess their condition. In fact, in the United States alone, unperformed maintenance totals approximately $66 billion. This means that there are a lot of vehicles on the road that need maintenance. This creates a safety issue for motorists due to accidents and breakdowns. It also has a financial cost, seeing that regular maintenance can extend the useful life of a vehicle by more than 100,000 miles (160,934 km). Because vehicle inspections are so important, technicians of all levels perform these inspections (**FIGURE 13-1**).

FIGURE 13-1 Regular inspection of a vehicle's systems helps ensure safe and reliable operation.

There are several levels of inspections that can be performed. Here are some of the common ones:

- Basic inspection (such as a 30-point inspection): Performed during oil changes or any time a vehicle is in the shop.
- In-depth inspection (such as a 128-point inspection): Commonly performed when the vehicle hits certain milestones, such as at 100,000 miles (160,934 km).
- State safety inspection: This is required by some states every one to three years. It verifies that the vehicle meets minimum safety requirements.
- Certified used car inspection: Many car dealers sell certified used cars. They use a specific inspection form. This certifies that the vehicle meets certain minimum specifications as listed in the form. Areas that do not meet the specifications are brought up to those specifications.
- Vehicle prepurchase inspection: Performed when a customer wants to purchase a noncertified used vehicle to make sure that it is in good condition.

Most shops use inspection forms to ensure a thorough and efficient inspection. These forms provide documentation of the inspection results. They can be paper forms that the technician fills out by hand (**FIGURE 13-2**). This, however, makes storage for long-term reference a challenge. A more efficient solution is to use electronic forms, which are filled out on a tablet or computer (**FIGURE 13-3**). They can be stored electronically and recalled at any time. The information is then used to inform the customer of their vehicle's condition and the cost to repair any issues found (**FIGURE 13-4**).

One example of an innovative product on the market is called *Cherry Inspect* (www.drivecherry.com). This is

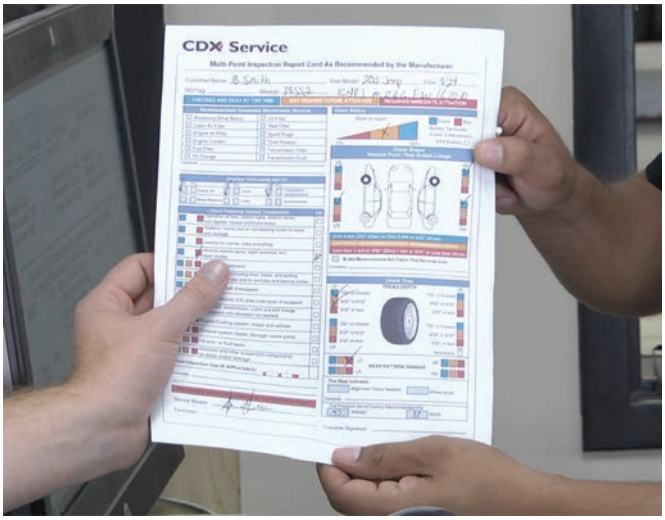


FIGURE 13-2 Sample paper inspection form.

FIGURE 13-3 Sample electronic inspection form on a tablet.
Courtesy of John Griffin, CEO of Drive Cherry.

a purpose-built electronic inspection system. It allows a shop to customize its inspection forms to fit its needs. Because it is electronic, it includes several time-saving features. In fact, it speeds up the inspection time approximately 40% over paper forms. This allows for increased productivity because more work can be performed in a shorter amount of time.

The system allows the technician to include written notes and pictures (**FIGURE 13-5**). This is valuable information for customers, as it gives them solid evidence on which to base their repair decisions. Plus, this system provides evidence that the customer was notified of the condition. This is important in the event that a customer refuses the recommended repairs and has an accident. It then becomes evidence if there is a liability lawsuit filed.

SERVICE CENTER
Cherry Auto Shop
1412 legend hills drive
suite 230
Clearfield, Utah
84015

NAME: Tyler Jeffrey
VEHICLE INFORMATION PROVIDED BY CARFAX
YEAR:2011
MAKE:B329ZP
MODEL:1500
ENGINE SIZE:
VIN:1D7RV1CT0BS676739
LICENSE PLATE:B329ZP
LICENSE PLATE STATE:UT
EXPIRATION DATE:10-19

INSPECTION REPORT:Report on Conditions INSPECTION COMPLETED:10-03-2018 17:39 PM

18 Recommended Items	3 Attention Items	6 OK Items
1. Oil Change Due QTY - 1 - *oil* 2. Front Lights QTY - 1 - 3. Driver Front Daytime Running Light QTY - 1 - 4. Pass. Front Daytime Running Light QTY - 1 - 5. Headlight Cleaning QTY - 1 - *SEE PICTURE # 5* 16. Rear Tires QTY - 1 - *Tires Below 4/32- Recommend Replacement* 17. Brake Pads- Front QTY - 1 - *brakes measure at 2MM* - *SEE PICTURE # 6* 18. Brake Pads/Shoes - Rear QTY - 1 - *brakes measure at less than 1 MM* - *SEE PICTURE # 7*	1. Tire Pressure Monitor System QTY- -1 - *Tire Pressure Monitor System Damaged Prior* 2. Engine Light QTY- -1 - *check engine light on prior* 3. Oil level	1. Oil System Cleaner (CUSTOMER SELECTED) 2. Service Indicator Light 3. TPMS Light 4. Windshield condition 5. Air Filter 6. Exhaust/Muffler System

PICTURE #1- Back Lights | PICTURE #2- Belts | PICTURE #3- Battery | PICTURE #4- Battery Terminal Cleaning

FIGURE 13-4 Sample summary sheet from an electronic inspection system (Cherry Inspect).
Courtesy of John Griffin, CEO of Drive Cherry.

FIGURE 13-5 Showing a customer their vehicle's issue using an electronic inspection system.
Courtesy of John Griffin, CEO of Drive Cherry.

When you perform an inspection, it is important that you are accurate and detailed. This means that you are performing the inspection according to the manufacturer's specified procedure. It also means comparing the results to their specifications. This usually means taking measurements and using objective criteria for your evaluation. You should not guess. For example, it is best to measure the tread depth instead of guessing the percentage of life left in the tire. Once you have the objective results, you can compare them to the manufacturer's specifications. Together, these will give you valuable information to share with the customer. You can then inform the customer of the condition of their vehicle and what is needed to maintain it.

A complete inspection includes everything that should be inspected and the level of inspection needed. Nothing should be missed. This means that the inspection needs to be organized in a manner that prevents missed items. This chapter explains what to look for and how to perform these important inspections.

In-Vehicle Inspections

LO 13-1
Perform in-vehicle inspection.

It would be easy to assume that customers would be aware of any in-vehicle concerns in their vehicle and therefore report them. However, many drivers either ignore them or do not realize that they indicate a problem. Do not overlook this critical inspection. In fact, certain in-vehicle inspections should be made as you drive the vehicle into the service bay.

Pay attention to the instrument cluster and warning lights. Also, note how the pedals feel and how the vehicle sounds when first started and as you drive it into the stall. If the **malfunction indicator lamp (MIL)** is illuminated while driving the vehicle, you will likely need to retrieve a **diagnostic trouble code (DTC)**, or perhaps several, from the onboard computer. This is done using a scan tool. As always, document any unusual findings and report them to your supervisor or service advisor.

TECHNICIAN TIP

The customer may have become used to the way the vehicle drives and feels. Yet there may be concerns such as a squishy brake pedal or play in the steering wheel that the customer doesn't notice. It is up to the technician to detect faults when the customer thinks the fault is just a normal condition.

Checking the Brake Pedal

The brake pedal acts as a lever to increase the force applied to the brake assemblies by the driver. Changes to

FIGURE 13-6 Always feel the brake pedal before starting the vehicle.

how far the pedal travels or to its resistance—if it feels harder or softer than normal—can indicate a problem in the braking system. Once you start the engine, check the brake pedal feel and travel before driving the vehicle into or out of the shop (**FIGURE 13-6**). If the pedal is low, extremely squishy, or hard, do *not* drive the vehicle.

Also, listen for unusual brake noises when driving the vehicle into the shop. High-pitched scraping noises or heavy grinding noises could indicate worn brake lining. The vehicle owner may be used to the feel of a low pedal or the sound of noisy brakes, whereas you will recognize it as an indication of a problem. See Chapter 48: *Hydraulics and Power Brakes Theory* for more information on how to service the braking system.

Checking the Parking Brake

All vehicles must be manufactured with a service brake and a parking brake. The service brake is designed to slow or stop the vehicle when driving. It uses a foot-operated pedal to apply brake units hydraulically at all four wheels. The parking brake is designed to hold the vehicle when it is parked. It uses either a hand-operated or a foot-operated lever to mechanically apply the brake units at only two wheels.

The parking brake should be checked as part of a routine safety or vehicle inspection. This level of inspection involves applying the parking brake and observing how far it travels before engaging. If it goes all the way to its stop, or near its stop, it fails this test and will need further attention (**FIGURE 13-7**).

In climates with below-freezing temperatures, the parking brake cable can freeze in the applied position. This keeps the parking brake from releasing. In freezing conditions, it is probably best not to test the parking brake operation. See Chapter 50: *Disc Brake System Theory* for more information on servicing the parking brake.

FIGURE 13-7 This parking brake goes too far before it is fully applied, requiring further attention.

TECHNICIAN TIP

If the vehicle does not have a hand- or foot-operated parking brake, check for a *P* button on the console or dash. The vehicle may be equipped with an electronically controlled parking brake.

Checking the Instrument Panel Warning Lamps

The many **instrument panel warning lamps** can mean faults with various systems on the vehicle. If a fault is detected, the appropriate warning lamp will be illuminated. Warning lamps can also mean correct operation of the system. Each warning system performs a self-check each time the ignition is switched on or the engine is cranked.

You should observe the action of the warning lights when starting the vehicle to determine whether any additional service may be required. For example, the amber **antilock brake system (ABS)** warning lamp will come on, then stay on for a few seconds, and then go off. This means that the ABS control module has successfully completed a preliminary self-check. The same thing happens with the **on-board diagnostics generation II (OBD-II)**. It turns on the MIL during the bulb check and then turns it off once the engine starts and no DTCs are stored in memory. Each of the warning lights or messages should turn off within a short amount of time, usually seconds, not minutes. To check instrument panel warning lamps, follow the steps in **SKILL DRILL 13-1**.

Retrieving Diagnostic Trouble Codes

The OBD-II system tests and analyzes each of the engine's systems while the vehicle is being operated. The computer

will set and store DTCs if a fault is detected. When performing an in-vehicle inspection, check to see whether the MIL is illuminated. If it is, it is important to retrieve any DTCs stored in the vehicle's computer memory. These codes will indicate which faults have been detected in the system. They will be useful when informing the customer of the status of their vehicle. They also give the technician valuable information when diagnosing the fault.

DTCs are retrieved with a scan tool. The scan tool plugs into the vehicle's data link connector (DLC), which allows the scan tool to communicate with the vehicle's computer. The technician selects menu items to get to the *retrieve codes* option. Once selected, the scan tool displays any current and pending DTCs. Document those codes on the inspection system. To retrieve and record DTCs, follow the steps in **SKILL DRILL 13-2**.

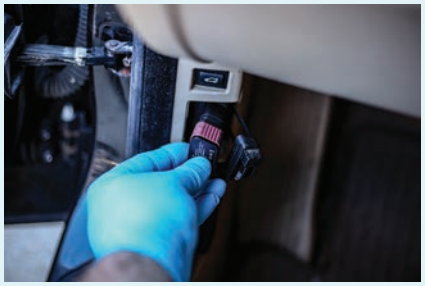
SKILL DRILL 13-1 Checking Instrument Panel Warning Lamps

1. Perform an instrument panel self-test. When the key is switched on (before starting the engine), most of the dash warning lamps will light up as a bulb check. Note any that do not light up as expected.

2. Perform an engine running check. Start the engine and observe the warning lamps. All should go off after a few seconds as the related control module runs a self-check and then commands the lamp to go off.

SKILL DRILL 13-2 Retrieving and Recording DTCs

1. Select the scan tool to provide the best coverage for the type and make of vehicle.

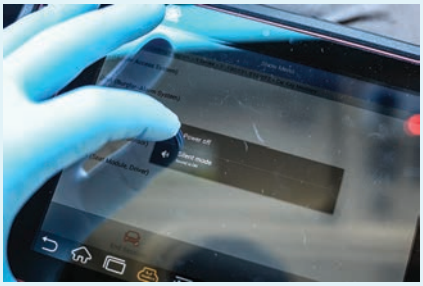


2. Locate the DLC and connect the scan tool.

3. Power on the scan tool.

4. Turn on the vehicle's ignition. This should establish scan tool communication with the vehicle's computer.

5. Retrieve and record the DTCs.



6. Power off the scan tool, turn off the ignition, and disconnect the scan tool.

TECHNICIAN TIP

Never erase the DTCs until all testing and repairs have been completed. Even then it may be best to allow the computer to clear them automatically. This is done after the vehicle performs a specified number of drive cycles after the problem has been corrected.

Checking the Horn

The vehicle horn is usually operated by either a relay or the vehicle **body control module (BCM)**. There may be a single horn or a pair of horns, depending on the vehicle. With two horns, one sounds at a lower pitch than the other. The horns are located at the front of the vehicle, behind the grill or bumper. The horn can easily be checked before driving the vehicle into the shop. Do *not* operate the horn in an annoying manner. To perform a horn check, follow the steps in **SKILL DRILL 13-3**.

SKILL DRILL 13-3 Performing a Horn Check

1. Check the vehicle horn. Turn on the ignition and press the horn button. The horn should sound.
2. If the horn is not working, locate it under the hood with the help of the manufacturer's service information. Check the wiring to make sure that it is connected securely.

Checking the Interior Lights

The interior lights provide illumination to the inside of the vehicle. This includes the courtesy lights, dome lights, vanity lights, and map lights. Activating the key fob or opening the driver side door should activate the courtesy lights and the dome light(s). Some of these lights are on a timer and stay on for a specified amount of time before they shut off. This gives the driver time to insert the key into the ignition.

Once the door is closed and the lights are off, you should be able to turn the dome light(s) on by either a switch on the dome light or a switch on the dash. Vanity lights are typically on the back side of the sun visor. A switch will turn them on and off. Map lights typically turn on automatically when they are moved into a position in which they can be used. To inspect the interior lights, follow the steps in **SKILL DRILL 13-4**.

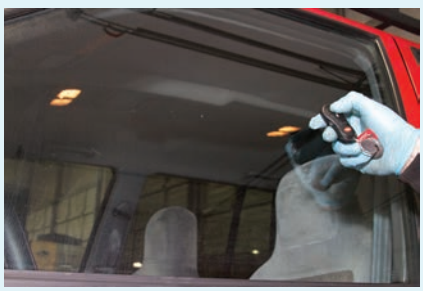
Underhood Fluid Inspection

LO 13-2

Perform fluid inspection.

A check under the hood is important to the life and operation of the vehicle (**FIGURE 13-8**). The inspection should be performed at the manufacturer's recommended intervals and also prior to any long trip. Component damage

SKILL DRILL 13-4 Checking the Interior Lights



1. Using the remote key fob or door key, unlock the doors. On most vehicles, this causes the interior lights to come on. Check that each light works as intended. On some vehicles, the lights do not come on until the door is opened. Check each door on the vehicle.

2. Enter the vehicle and close the door. Wait to see that the lights go off after a time. Repeat this check with each door on the vehicle.

3. Operate the courtesy lights from any other switches. Check the vanity lights and map lights, if equipped.

FIGURE 13-8 A check under the hood is vital to the life and operation of the vehicle.

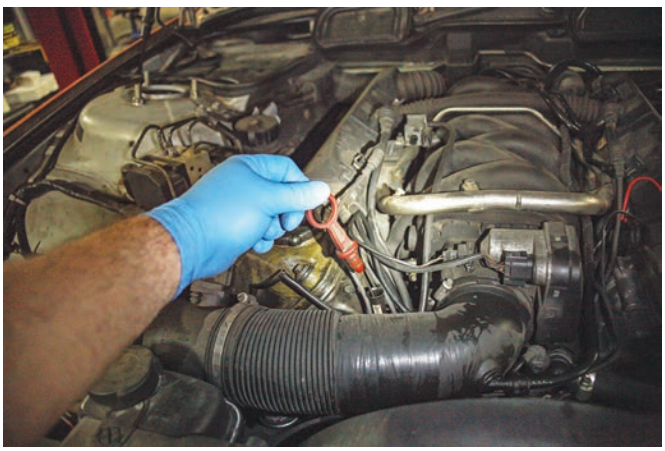


FIGURE 13-9 All fluids need to be checked for the correct level.

or failure is often caused by a lack of maintenance or low fluid level in the related system. For example, low oil level in the engine can cause major damage to the engine bearings and crankshaft. Future problems also can be prevented by a thorough inspection of the underhood fluids. The discovery of a low fluid level may help avoid a breakdown on the highway.

Some of the fluids used in a vehicle, such as engine oil, are needed to keep the mechanical systems lubricated and functioning correctly. Other fluids may be safety related, such as windshield washer fluid and brake fluid. No matter what the fluid, they all need to be at the correct level (**FIGURE 13-9**). Always use the manufacturer's recommended type and amount of fluid when checking these items.

For the engine, the engine oil and coolant levels must be checked. The brake, hydraulic clutch, and ABS all depend on the correct level of brake fluid. Power steering fluid and transmission fluid need to be at the recommended level for these systems to operate correctly. The windshield washer fluid level should be checked and topped off as needed.

FIGURE 13-10 Checking fluid appearance.

Just as the level of the fluid is important, so too is the quality of the fluid (**FIGURE 13-10**). Nearly all the fluids in a vehicle get old and wear out, requiring replacement. The one exception is some automatic transmission/transaxle fluids. Whenever you check the level of any fluid, check the quality of the fluid too. You might notice a change in color, a change in consistency, a mix of fluids, or a change in smell, such as burned transmission/transaxle fluid. Each fluid shows its age differently, so familiarize yourself with how to identify both good and bad fluids.

Checking Engine Oil

The level of the oil in the engine's lubrication system is critical to the engine's operation. The engine oil is picked up by the oil pump, filtered through the oil filter, and then sent under pressure to the crankshaft and camshaft bearings. If the level is too low, the oil pump will starve for oil. If the level is too high, the crankshaft will strike the oil, churning it into foam. Either condition causes a lack of lubrication, which can damage the engine bearings and other internal engine parts (**FIGURE 13-11**).

The engine oil level should be checked periodically, usually at every other fuel stop, as part of a preventive maintenance plan. Always check the oil level when the vehicle is on a level surface, not on a hill or slope. The oil can be checked with the dipstick, which is usually marked *oil* or is brightly colored (**FIGURE 13-12**). The marks on the bottom of the oil dipstick typically have lines that indicate *full* and *add* or *min* and *max* (**FIGURE 13-13**). The difference in quantity between the add and the full marks on an engine oil dipstick is usually 1 quart (0.9 L) but can be as much as 2 quarts (1.9 L) on some vehicles. This can be verified in the vehicle owner's manual or the manufacturer's published service information.

Always check engine oil with the engine off. Wipe off the dipstick, identify the marks on the dipstick, and

FIGURE 13-11 Parts damaged by lack of lubrication.

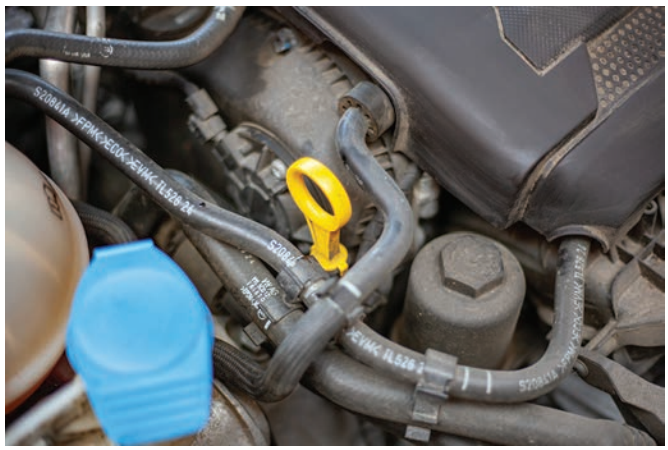


FIGURE 13-12 The oil dipstick is usually marked *oil* or is brightly colored.

FIGURE 13-13 Oil dipsticks typically are labeled either *full* and *add* or *min* and *max*.

reinsert it fully in the tube. Then pull it out and hold it horizontally to read it (**FIGURE 13-14**). It is also a good idea to flip the dipstick over and compare the oil level on the back side with the level shown on the front side. The lowest reading on either side is likely the most accurate (**FIGURE 13-15**).

FIGURE 13-14 Hold the dipstick level when reading it.

FIGURE 13-15 Flip the dipstick over and compare the reading on both sides. The lowest reading is the most accurate.

FIGURE 13-16 Oil-life monitoring system.

When checking the oil level, also consider determining whether it is time for an oil change. There are two ways to identify this. If the vehicle is equipped with an oil-life monitoring (OLM) system, it will show the percentage of oil life remaining (**FIGURE 13-16**). If it is not equipped with an OLM, the service information will show the recommended mileage or time interval between changes (**FIGURE 13-17**).

If the vehicle is due for an oil change, the level should still be checked first. A low reading on the dipstick

FIGURE 13-17 Service information listing the recommended oil and filter change mileage or time interval.

could indicate that a seal or gasket is leaking or that the engine is using oil. Either of these situations requires further investigation. Refer to the service information to select the correct oil for the vehicle (**FIGURE 13-18**). If the vehicle requires an oil change, refer to Chapter 18: *Engine Lubrication System Theory*. It includes skill drills on how to change the engine oil and filter.

Checking Engine Coolant

The engine cooling system depends on the coolant to transfer excessive heat from the engine to the radiator. Coolant level is critical to this. Check the engine coolant level and condition whenever the oil level is checked. Low coolant levels indicate a coolant leak that must be diagnosed and repaired.

To check the coolant level, some vehicles have a transparent reservoir or surge tank marked with *hot* and *cold*. This allows checking the coolant without removing the cap (**FIGURE 13-19**). Some vehicles may also have an overflow tank with a tube leading from the radiator cap filler neck to a transparent overflow tank. The level can usually be seen through the side of the tank and compared to the marks, which indicate the hot or cold fluid levels. Older vehicles may not have an overflow tank. To check them, remove the radiator cap and confirm that the coolant level in the radiator is about 1.5" (38.1 mm) below the filler neck.

SAFETY TIP

Do not remove the pressure cap (radiator cap) when the engine is warm or hot. The system is under pressure, and removing the cap could allow the coolant to boil and spray out immediately, causing severe burns. Always allow the system to cool before removing the cap.

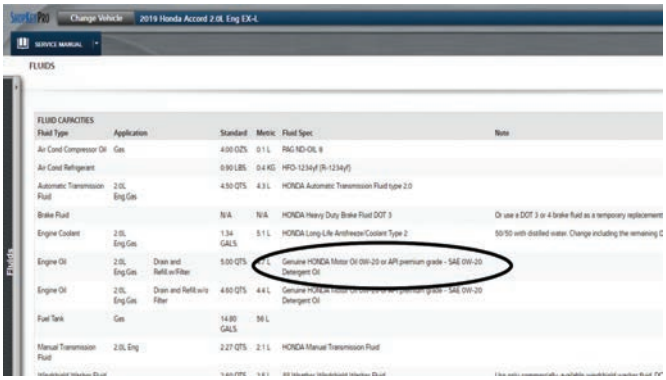


FIGURE 13-18 Service information showing the specified oil for a vehicle.

FIGURE 13-19 Checking the coolant level on a clear reservoir.

Because the coolant also provides freeze protection, the coolant's freeze point also should be checked. A weak antifreeze solution could allow the coolant to freeze during cold temperatures. Water expands when frozen. Freezing of the coolant could crack the engine block, radiator, or other cooling system parts. The freeze protection level can be measured with an antifreeze hydrometer, as shown in **SKILL DRILL 13-5**.

A refractometer can also be used to measure the freeze protection level of coolant. A drop or two of coolant is placed on a sample plate and the cover closed. Looking through the viewfinder, you can read the protection level. In many cases, there are several scales you will be able to see. Common scales include battery acid, ethylene glycol antifreeze, and propylene glycol antifreeze. Make sure that you are reading the correct scale. To measure the freeze protection of coolant with a refractometer, follow the steps in **SKILL DRILL 13-6**.

Checking Brake and Clutch Fluid

A hydraulic braking system depends on a special fluid called *brake fluid*. Brake fluid is stored in a reservoir attached to or near the brake system master cylinder

SKILL DRILL 13-5 Using a Hydrometer to Measure the Freeze Protection Level of Antifreeze

1. Select a hydrometer that is designed for use with the type of antifreeze being tested.

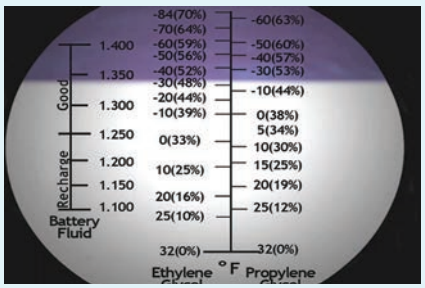
2. Draw enough coolant into the hydrometer to bring it up to the *fill* line.

3. Hold the hydrometer vertically and read the freeze protection level.

SKILL DRILL 13-6 Using a Refractometer to Measure the Freeze Protection Level of Coolant

1. Remove the radiator cap and draw out a few drops of coolant.

2. Place a drop or two of the coolant on the sample plate.



3. Close the diffuser plate, hold the refractometer level, look through the viewfinder, and read the scale.

(**FIGURE 13-20**). If the brake fluid level gets too low, air can be pulled into the hydraulic system, which causes the brake pedal to be soft and too low. This causes the brakes to work poorly or not at all.

TECHNICIAN TIP

Brake fluid test strips use leached copper content in the brake fluid to show moisture contamination. The copper leaches from the steel brake lines. Because of this, hydraulic clutch systems that use plastic master cylinders and clutch lines cannot be tested with test strips. A brake fluid tester should be used in this situation.

FIGURE 13-20 The brake fluid is stored in a reservoir attached to or near the brake system master cylinder.

The brake fluid should be checked whenever the oil level is checked, or at least monthly. Also, check the color of the brake fluid. Most brake fluid is clear. If it is getting dark, it is most likely becoming oxidized or contaminated and needs to be changed. Most brake fluids are **hygroscopic**, meaning they absorb water from the atmosphere. Because of this, most manufacturers recommend changing brake fluid every two to four years. However, the best process is to check the condition of the brake fluid with either a brake fluid tester or brake fluid

APPLIED Math

AM-1: Ratios/Percentages: ***The technician can convert test readings in decimal or fractional form to a ratio or percentage form for comparison with the manufacturer's specifications, and vice versa.***

A technician is servicing the cooling system of a vehicle with a 12-quart (11.4 L) capacity per service information. The location has a cold climate. The shop supervisor directed the technician to fill the cooling system with a 60/40 mix of antifreeze and distilled water. Considering that the total capacity of the system is 12 quarts (11.4 L), the technician needs to convert the percentages to a fractional form.

This can be done by multiplying the total quantity by each percentage: 12 quarts × 60% is 12 × 0.60, which equals 7.2 quarts (6.8 L) of antifreeze. Then 12 quarts × 40% is 12 × 0.40, which equals 4.8 quarts (4.5 L) of distilled water.

Most climates require a 50/50 mix of antifreeze and water. This can be converted to a ratio or percentage form. Six quarts of distilled water and 6 quarts (5.7 L) of antifreeze would be a 1:1 ratio. In percentage form, we have 50% distilled water and 50% antifreeze. This is often referred to as a 50/50 mix.

TECHNICIAN TIP

Low master cylinder brake fluid levels usually indicate one of two possible issues with the system: either there is a brake fluid leak in the system or the disc brake pads are worn. If the brake fluid level is low, inform your supervisor; it may be necessary to perform a brake inspection.

test strips. Review the service information or the owner's manual for the specified fluid type.

Vehicles with a manual transmission may have a hydraulic clutch system that uses brake fluid. Depending on the vehicle, the brake master cylinder reservoir also may supply the clutch master cylinder, or the clutch may have a separate fluid reservoir (**FIGURE 13-21**). Be sure to check both of these reservoirs for the correct fluid level. Refer to Chapter 48: *Hydraulics and Power Brakes Theory* for an explanation of the different types of brake fluid.

Checking Power Steering Fluid

Most vehicles are equipped with power-assisted steering systems. The power for the system usually comes from an engine-driven hydraulic pump. Some vehicles use an electric motor to drive a hydraulic pump or directly operate the steering linkage. These systems are typically found on hybrid electric vehicles.

FIGURE 13-21 Some hydraulic clutches use a reservoir separate from the brake master cylinder.

A

B

FIGURE 13-22 The power steering fluid reservoir. **A.** Mounted on the engine-driven hydraulic pump. **B.** Mounted separately.

The pump delivers fluid under pressure to the power unit at the steering box or rack and pinion. The fluid reservoir can be mounted as part of the engine-driven hydraulic pump, or it can be a separate container (**FIGURE 13-22**). The power steering fluid must be at the appropriate level to avoid drawing air into the hydraulic

FIGURE 13-23 Checking power steering fluid.

FIGURE 13-24 The transmission dipstick is usually located near the front of the transmission.

system. It also must prevent fluid overflow when the engine is hot.

In most cases, the power steering fluid level can be checked with a dipstick connected to the filler cap. The engine should be idling, and the fluid should be hot. In many cases, the dipstick lists both a *cold* and a *hot* level, or a *safe* level (**FIGURE 13-23**). When checking the level, you also should check the appearance of the fluid. Dark or black fluid usually means that the fluid is old and needs to be changed. The power steering fluid level should be checked as a normal part of the underhood inspection. Refer to Chapter 43: *Servicing the Steering System* for more information on power steering fluid types and how to service them.

Checking Automatic Transmission/Transaxle Fluid

The correct automatic transmission/transaxle fluid level (referred to as *automatic transmission fluid* from here on) is critical to the effective operation of the transmission. If the level is too low, slipping and shift timing faults can result. Because reverse gear usually requires a larger volume of fluid, a delayed shift into reverse could be an early indication that the fluid is low. If the fluid level is too high, the transmission fluid will churn and aerate. This can lead to low pressures, resulting in slipping clutches. Always make sure that the transmission fluid level is correct.

Automatic transmission fluid level is typically checked with a dipstick located under the hood. This is usually near the front of the transmission (**FIGURE 13-24**). Some automatic transmissions do not have a dipstick; they are checked using a fill plug, or level plug, on the side of the transmission (**FIGURE 13-25**). If the transmission does use a dipstick, the fluid level is typically checked with the engine running, the transmission warmed up fully, and the gear selector in park or neutral, depending on the vehicle.

FIGURE 13-25 Some automatic transmissions are checked using a fill plug, or level plug, on the side of the transmission.

To check the automatic transmission fluid level using a dipstick, follow the steps in **SKILL DRILL 13-7**.

When adding transmission fluid, make sure that you select the correct fluid. There are several different transmission fluids specified for various vehicles. Fluid is added through the dipstick tube, so use a funnel. The lines between *full* and *add* are usually only about 1 pint (0.5 L), so add only a small amount of fluid at a time, checking the fluid level regularly.

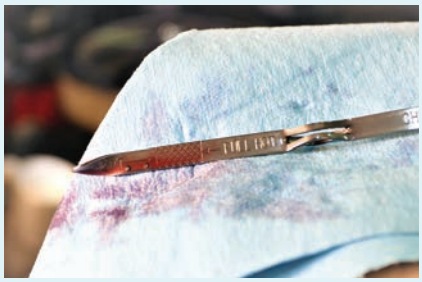
In recent years, vehicle manufacturers have been eliminating the transmission dipstick on some of their vehicles. This prevents the vehicle owner from installing the incorrect fluid or overfilling the transmission. It also provides one less entry point for dirt and contaminants to enter the transmission.

On transmissions without a dipstick, it is critical to check the service information for the correct procedure for checking the fluid level. Many late-model Ford and Toyota vehicles have what looks like a drain plug installed in the transmission pan. With the vehicle running, this plug is

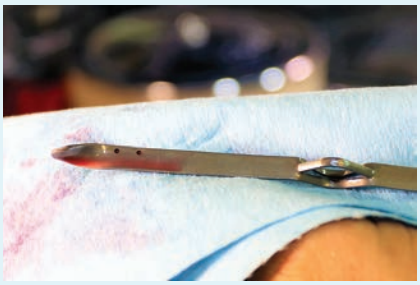
SKILL DRILL 13-7 Checking Automatic Transmission Fluid Using a Dipstick

1. When checking transmission fluid, first wipe off the dipstick.

2. Observe the markings.



3. Reinsert the dipstick fully, remove it again, hold it horizontal, and read it.



4. Turn over the dipstick and read the back side. The lowest reading between the front and the back is likely the most accurate reading.

removed. Fluid is forced up, into the transmission, through either this hole or a separate fill hole (**FIGURE 13-26**). The hole may have a tube attached to it inside the transmission. Once the fluid level is full, excess fluid simply drains back out. The plug can then be reinstalled.

TECHNICIAN TIP

Many newer vehicles—typically European models and some Asian imports—do not have a specified method of checking the transmission fluid level. The transmissions are considered sealed and lubricated for the life of the vehicle. The manufacturers have determined that the transmission fluid will not be low as long as there are no leaks. Any leak requires that the transmission be repaired.

General Motors vehicles often have a threaded plug, located on the transmission case. The plug is removed while the vehicle is idling with the engine at a specified coolant temperature. Again, fluid is added until transmission fluid flows out of the hole and then the plug is reinstalled (**FIGURE 13-27**).

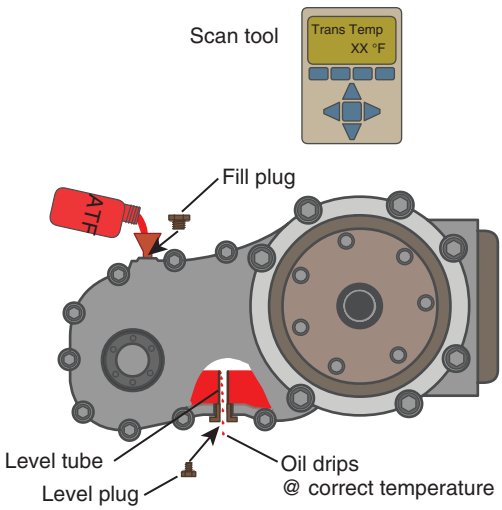


FIGURE 13-26 On transmissions with the fill tube on the bottom of the pan, once the fluid is at the correct level, additional fluid spills out.

Checking Manual Transmission/ Transaxle Fluid

In most cases, the transmission fluid level on manual transmissions/transaxles, transfer cases, and differentials can be checked only from under the vehicle. This will be covered in the Under-Vehicle Inspection section of this chapter.

Checking Diesel Exhaust Fluid

Some late-model, diesel-powered vehicles use a fluid called **diesel exhaust fluid (DEF)**, one example being AdBlue®. DEF is injected into the exhaust stream to

FIGURE 13-27 On transmissions with a fill plug on the side of the transmission, fill until transmission fluid just starts to come out.

FIGURE 13-28 Adding DEF to the reservoir.

reduce oxides of nitrogen during certain driving conditions. Because DEF is consumed over time, it has to be replenished periodically, ideally during oil changes. The DEF filler cap is often located under the hood and may be blue colored (**FIGURE 13-28**). *Do not* make the expensive mistake of putting washer fluid (or any other fluid) in the DEF tank.

Checking Windshield Washer Fluid

The windshield washer system on any vehicle is an important safety feature. Driving in muddy conditions, light mist, or fog requires that the washer system be ready to work when needed. The washer fluid reservoir is normally located under the hood of the vehicle (**FIGURE 13-29**). Some vehicles also may have a separate washer reservoir for the rear wiper. It is typically located somewhere in the rear hatch or trunk area. Refer to the owner's manual or service information to locate the filler cap.

The windshield washer fluid should be checked whenever the oil is changed or at each vehicle service. Driving in dusty conditions may require that the windshield washer fluid be checked more often. It is important to use properly formulated and mixed washer fluid, especially in freezing weather. The fluid is normally purchased premixed in the appropriate ratio to protect against freezing. To check and add to the windshield washer fluid, follow the steps in **SKILL DRILL 13-8**.

TECHNICIAN TIP

Never use laundry or dishwashing detergent to top off the reservoir. The chemicals in the detergent can damage the vehicle's paint.

FIGURE 13-29 The washer reservoir is usually located under the hood.

Engine Drive Belts

LO 13-3

Perform belt, hose, and air filter/cabin air filter inspection.

Engine drive belts are used to operate the various accessories on the engine. Examples include the water pump, power steering pump, air-conditioning compressor, and alternator. As the vehicle ages, these belts wear, as do their associated idler and tensioner pulleys. Some manufacturers recommend that the belts be replaced at about five years of age, as part of a preventive maintenance program.

A newer belt technology is becoming more common. These are called *stretchy belts* or, as one manufacturer named theirs, *stretch-fit belts*. They do not use a tensioner for tensioning the belt. Their stretchiness applies an appropriate amount of tension to the belt over its useful life. Some vehicle manufacturers claim that this can be up to 150,000 miles (241,402 km). Always check the manufacturer's scheduled service guide for belt replacement intervals.

SKILL DRILL 13-8 Checking and Refilling Windshield Washer Fluid

1. Locate the front windshield wiper fluid container.

2. Check the windshield washer fluid level. If the level is low, refill the reservoir with the appropriate washer fluid.

3. If equipped, check and fill the rear window washer reservoir.

There are two main types of accessory drive belts: the V-type and the serpentine type (**FIGURE 13-30**). A V-belt sits inside a deep V-shaped groove in the pulley. The sides of the V-belt contact and wedge in the sides of the pulley. Serpentine-type belts have a flat profile with several grooves running lengthwise along the belt. These grooves are the exact reverse of the grooves in the outer diameter of the pulleys. They increase the contact surface area and prevent the belt from slipping off the drive pulley as it rotates. Sometimes road debris or pieces of drive belt get stuck in the pulley grooves and must be meticulously cleaned out with sharp picks or wire brushes.

Visually inspect the drive belts whenever the hood is opened for service. The engine will quickly overheat if the belt breaks or comes off. This happens because the water pump is the most important component driven by the belt.

If the belts are more than five to six years old, check the manufacturer's replacement schedule in the service information. Most vehicles using a serpentine belt also have a spring-operated tensioner and pulley. This tensioner may have a built-in damper that reduces noise and vibration. Some manufacturers recommend that the tensioner be replaced along with the belt.

TECHNICIAN TIP

Some belts, called *stretchy belts* or *stretch-fit belts*, do not use a method for tensioning the belt. When removing them, they usually need to be cut with side-cutting pliers.

A

B

FIGURE 13-30 Drive belts. **A.** A V-type belt fits into the V of the drive pulley. **B.** Serpentine-type belts have a flat profile with several grooves running lengthwise along the belt.

The belts should be checked for the following:

- Cracks: Cracks that exceed a certain number per inch in a belt indicate that the belt may soon fail and should be replaced (**FIGURE 13-31**).
- Oil soaking: A belt that has been soaked in oil will not grip properly on the pulleys and will slip. If the oil contamination is severe enough for this to happen, replace the belt (**FIGURE 13-32**).

FIGURE 13-31 A serpentine belt with excessive cracks should be replaced.

FIGURE 13-32 Oil-soaked belt.

FIGURE 13-33 Glazed belt.

- Glazing: Glazing is shininess on the surface of the belt, which comes in contact with the pulley (**FIGURE 13-33**). If the belt is extremely worn, the glazing could be due to the belt bottoming out, and it should be replaced. If it is not old and worn, glazing could indicate that the belt is not tight enough. Tightening the belt may be all that is necessary, depending on how bad the glazing is.
- Tears: Torn or split belts are unserviceable and should be replaced (**FIGURE 13-34**).
- Bottoming out: When a V-type belt or serpentine belt becomes extremely worn, the bottom of the V may contact the bottom of the groove in the pulley, preventing the sides of the belt from making good contact with the sides of the pulley grooves. This reduced friction causes slippage. A belt worn enough to bottom out should be replaced (**FIGURE 13-35**). Serpentine belts are checked for wear using a small tool that fits into the grooves on the belt. The tool should sit higher than the ridges in the belt if the belt is still serviceable (**FIGURE 13-36**).

FIGURE 13-34 Torn belt.

Checking the Hoses

The vehicle usually has two large radiator hoses and some smaller heater hoses that carry hot coolant through the system (**FIGURE 13-37**). At the radiator, there is a large upper radiator hose and a large lower radiator hose. The smaller heater hoses (usually two) run from the engine block, manifold, or water pump to connections at the heater assembly (near the firewall).

The engine should be cool when inspecting the hoses. A hot engine has pressure in the cooling system that may make a soft hose feel stiff, when it really may need to be replaced. If the engine is hot, look for bulging in the hoses (**FIGURE 13-38**).

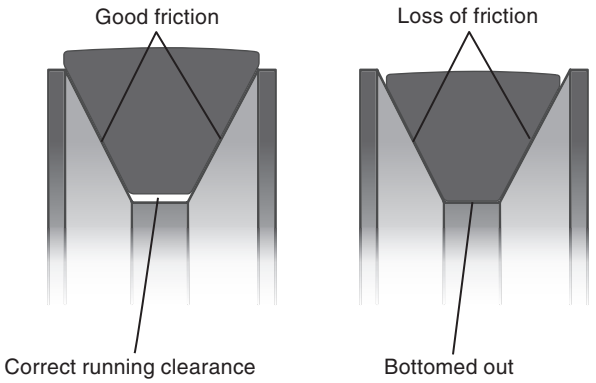


FIGURE 13-35 A V-belt worn enough to bottom out should be replaced.

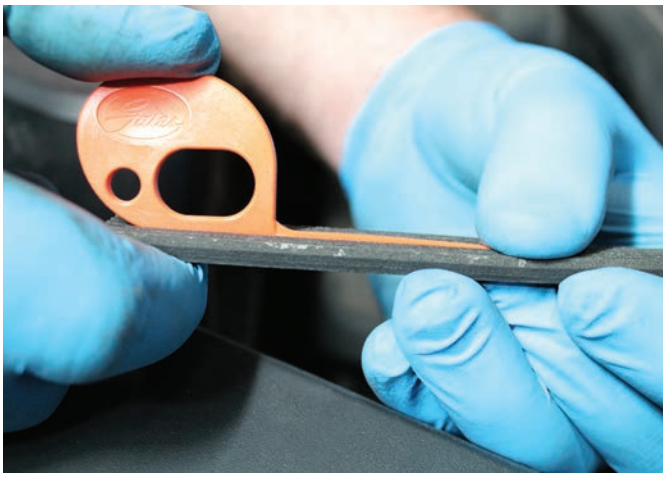


FIGURE 13-36 A serpentine belt wear tool should fit into each groove and still stick up higher than the ridges in the belt.

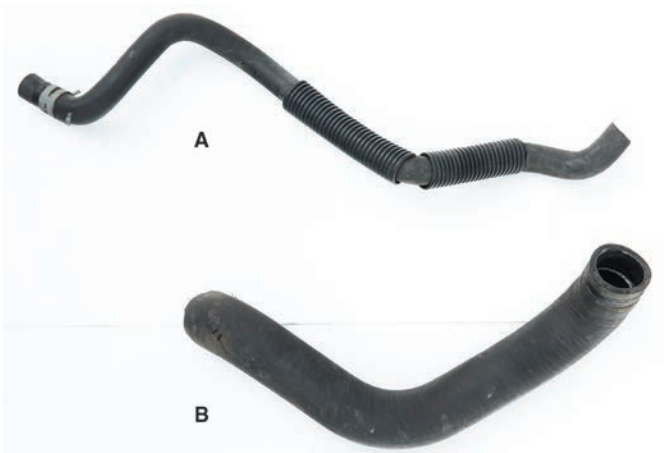


FIGURE 13-37 **A.** Heater hose. **B.** Radiator hose.

Checking the Air Filter

The engine needs a free flow of clean air to operate correctly. Dust and grit in the air can be very abrasive and will severely shorten the life of the engine if not filtered out. If the filter element is not fitted correctly and does not seal properly, dirty air can bypass the filter and enter the engine.

FIGURE 13-38 Inspecting coolant hoses.

TECHNICIAN TIP

In most cases, hoses need to be felt to determine their condition. They should be neither too hard nor too soft. Also, the relative stiffness should be consistent over the length of the hose. If you feel differences in stiffness, the hose should be replaced.

The location of the air filter varies depending on the type of fuel system on the vehicle. Check the service information for the exact procedure. Some air filters are mounted to the top of the engine, usually found on older vehicles using a carburetor or throttle body fuel injection. The air cleaner on a multiport fuel-injected vehicle is typically located in a rectangular box within the air induction system. While inspecting the air filter, check the air cleaner housing and ductwork for cracks or holes. These conditions could allow unfiltered air to enter the engine.

TECHNICIAN TIP

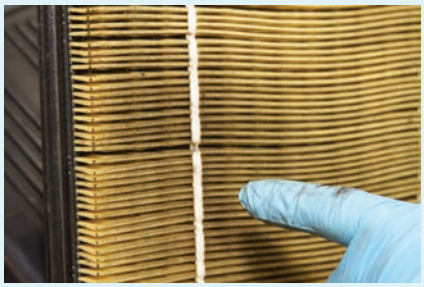
The paper filter element becomes more efficient at filtering dirt particles the more it is used. This is because the passageways become smaller as dirt is caught in them. Smaller and smaller dirt particles are caught over time. However, if the filter becomes too clogged, it will restrict air, which reduces engine power output.

Once the air filter is removed, it is fairly easy to inspect. First, check for any damage to the sealing surfaces. If they are bent or damaged, they will not seal dirt out and therefore must be replaced. If the filter is in good shape, then inspect it for clogging. This is best done by holding the filter up to the light and looking through it. If it is bright, then it is not clogged. If little or no light comes through, then it is clogged and needs to be replaced. To inspect and change the air filter, follow the steps in **SKILL DRILL 13-9**.

SKILL DRILL 13-9 Inspecting and Changing an Air Filter

1. On fuel-injected engines, unlatch or unscrew the filter housing fasteners to remove the air filter. It may be necessary to loosen the clamps and hoses on the induction tubing to remove the filter housing cover.

2. On carbureted or throttle body-injected engines, remove the top of the air filter by unscrewing the wing nut, and remove the air filter.



3. Inspect the air cleaner element by holding the filter element up to the light and looking through it. If it is bright, with no tears or cracks, it can be reused. If it is dark or damaged in any way, it needs to be replaced.

4. Clean the inside of the air filter housing, and inspect it and any ducts for cracks. If the air filter is being replaced, obtain a new air filter and compare it with the old one to ensure that they are exactly the same.

5. Place the new air filter inside the filter housing, making sure that it is aligned correctly on both sides.

6. Replace the cover of the air filter housing and tighten the latches, screws, or wing nuts until completely closed. Reinstall any induction tubing or clamps.

TECHNICIAN TIP

Just opening up the filter housing and looking at the top of the filter is not a proper way to inspect the filter. In most vehicles, the air flows *up* through the filter, so it is the bottom side that is the dirty side. Looking only at the top side of the filter will give you inaccurate information about the filter. Remove it and hold it up to the light.

Checking the Cabin Air Filter

Many vehicles now include a cabin air filter in the heating, ventilation, and air-conditioning (HVAC) system to filter the air before it enters the cabin. The filter is housed in the air box and can be accessed from one of a variety of positions, depending on the vehicle. The access may be from under the hood near the firewall, under the windshield, or behind the glove box (**FIGURE 13-39**). It is usually fairly easy to remove and replace once you find the access cover.

The cabin air filter should be inspected during every service and should be replaced according to the manufacturer's specified interval. Typically, this is once a year or every 12,000 to 15,000 miles (19,312–24,140 km). When inspecting the cabin air filter, use the same guidelines as for an engine air filter. Hold it up to the light, and look at it to see if the light shines through, or if it is blocked from being dirty. Also, check it for any cracks, tears, or deformities that would make it ineffective (**FIGURE 13-40**).

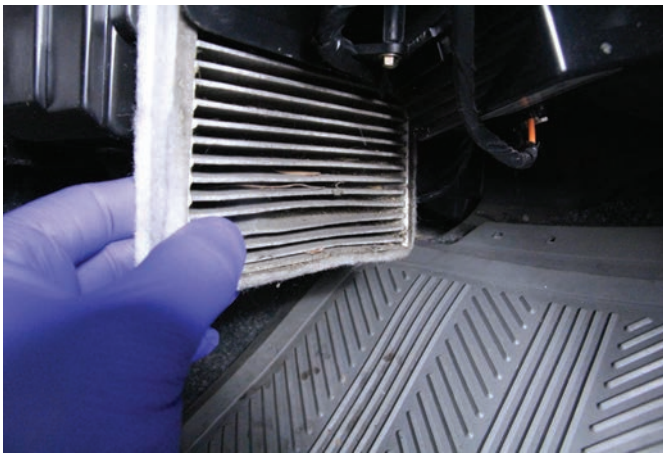
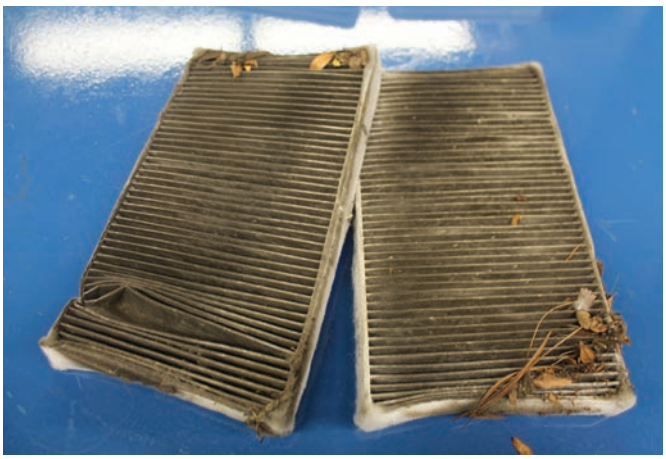


FIGURE 13-39 A typical location of a cabin filter.

A



B

FIGURE 13-40 Cabin filters. **A.** Clean. **B.** Dirty.

Under-Vehicle Inspection

LO 13-4

Perform under-vehicle inspection.

The under-vehicle inspection is a systematic visual inspection of all major vehicle systems that can be accessed from below. Because these parts are not accessible from above, they often get overlooked. Also, because they are exposed to the elements, they are prone to additional wear and damage.

FIGURE 13-41 An under-vehicle inspection is a good way to get a feel for the overall condition of the vehicle.

With the vehicle safely lifted on a hoist, an under-vehicle inspection is a good way to get a feel for the overall condition of the vehicle (**FIGURE 13-41**). Tire issues, leaks, worn parts, and structural damage can be found relatively easily. This allows you to inform the customer of any areas of concern before those concerns become real problems. Like all inspections, the results need to be documented on an inspection form. This can be done on paper or electronically, then given to your supervisor or service advisor to review with the customer.

Tire Inspection

The tires and their condition are one of the most important safety considerations on the vehicle. Tires should be checked for air pressure, wear patterns, damage, and tread depth. Tires that are underinflated or overinflated do not grip the road fully, and they tend to wear out sooner. Because tires lose air pressure over time, they need to be inspected and aired up periodically. This typically should be performed every three months or at every oil change.

Normal tire pressures vary from vehicle to vehicle. Recommended tire pressures for the vehicle are located on the vehicle manufacturer's tire placard. This is typically placed on the driver side door pillar (**FIGURE 13-42**). The maximum tire pressure, located on the tire sidewall, is the maximum pressure for that tire. It is *not* the recommended pressure for the vehicle (**FIGURE 13-43**). Never inflate the tire above the specified maximum pressure, as the tire may explode. Tires are inflated using compressed air or nitrogen (**FIGURE 13-44**).

FIGURE 13-42 Typical tire placard located on the door pillar.

FIGURE 13-43 Maximum tire inflation pressure. (Do not exceed!)

FIGURE 13-44 Adding air to a tire with a tire inflator.

Adequate tread depth and even tread wear are also important for safety. A tire worn to a minimum tread depth may work fine on dry pavement but can be dangerous in wet or snowy weather. Keep this in mind as you measure the tread depth. Also, tires do not always wear evenly. If this is the case, there is likely a steering, suspension, or tire inflation issue that needs to be identified. Always measure at least three places across the tread to identify uneven wear in the tread (**FIGURE 13-45**).

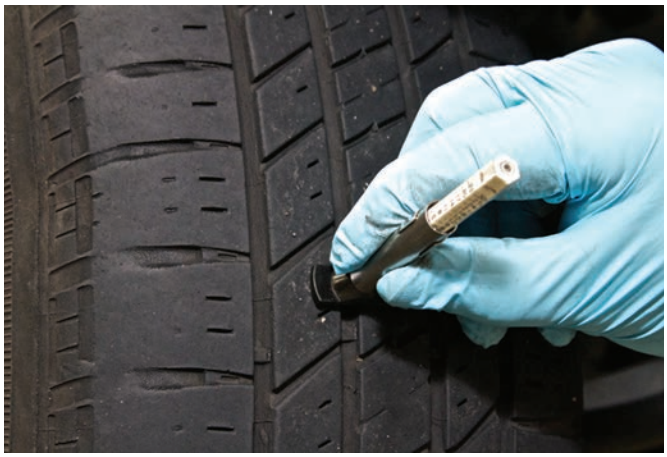


FIGURE 13-45 Tire being checked for wear patterns, damage, and tread depth.

FIGURE 13-46 Because bulges in tires are due to broken belts, often the steel cords stick out of the tread. Be careful not to run your hand across them.

Finally, inspect the tire for damage, bulges, and age. Damage shows up as deep cuts, gashes, or objects that penetrate the tire. Deep cuts and gashes typically require tire replacement. Tires that have been penetrated with an object can be repaired with a plug-patch, but the hole must be no bigger than 0.25" (6 mm) in diameter. It must also be located within the tire's tread (not on the sidewall).

Bulges happen when belts break or separate in the tire's carcass, and they require replacement of the tire. They can be located by running your hand over the tread and sidewalls of the tire and feeling for bulges. Just be aware that often steel cords will be exposed on tires with bulges (**FIGURE 13-46**). These can be very sharp. Always visually inspect the tire for exposed cords before running your hand over the tire.

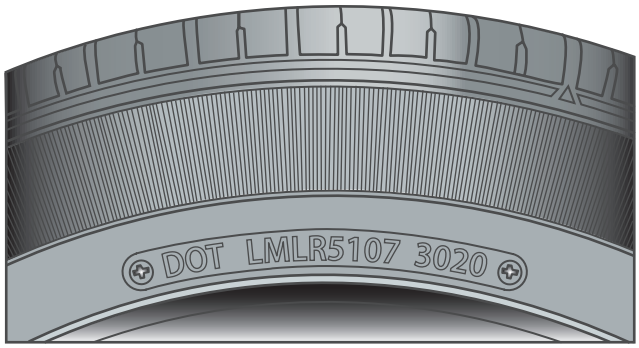


FIGURE 13-47 Four-digit DOT date code showing that this tire was manufactured in the 30th week of 2020.

Tire age is another important factor to consider when inspecting tires. Tires do not last forever. They have a useful service life that is typically between 6 and 10 years, depending on the manufacturer and the environment. It is hazardous to use a tire that has outlived its useful service life.

Tire age can be determined by locating the Department of Transportation (DOT) tire date code on the sidewall of the tire (**FIGURE 13-47**). Most tires use a four-digit code, where the first two digits are the week of manufacture, starting in January. The last two digits indicate the year. Therefore, a tire with a date code of 3020 means that the tire was manufactured on the 30th week of 2020. Refer to Chapter 41: *Servicing Wheels and Tires* for more information on wheels and tires.

Checking Manual Transmission/ Transaxle/Transfer Case Fluid

As a preventive maintenance task, the fluid level of the manual transmission, transaxle, and/or transfer case should be checked. In most cases, the fluid level on these components can be checked only from under the vehicle. The vehicle must be level. The level is usually accessed through a fill plug on the side of the transmission/transaxle. If fluid comes out of the fill hole when the plug is removed, allow any extra fluid to drain out and then reinsert the fill plug. If no fluid comes out of the fill hole, carefully stick a finger in the hole and bend your finger down to feel the level of the fluid (**FIGURE 13-48**). If the level is within 0.25" (6 mm) of the bottom of the fill hole, the level is okay, and the fill plug can be reinstalled. If the fluid level is lower than that, the appropriate fluid must be added until the level is even with the bottom of the fill hole. Some transmissions, such as those made by Ford and Audi, must be filled up until fluid spills out of the fill hole. Checking service information and technical service bulletins (TSBs) is critical for doing the job correctly.

Also, not all manual transmissions use gear lube. Some use engine oil of a specified viscosity. Others even use a specified type of automatic transmission fluid or another fluid called *Synchromesh*. Make sure that you check the service information to determine the correct type of fluid required, as shown in **SKILL DRILL 13-10**.

FIGURE 13-48 Checking the transmission fluid level in a manual transmission. (Note that this manual transmission specifies automatic transmission fluid.)

SAFETY TIP

Do not rotate the wheels or engine with your finger in the fill hole, as transmission parts could pinch or sever your finger.

Fluid level and condition can tell a technician a lot about what is going on inside the transmission. For example, consider metal filings found floating inside the transmission fluid. If this happens, then the technician knows that the transmission will have to be pulled apart or replaced. In the event of a suspected leak, the leak will need to be identified and repaired. Once repaired, the transmission fluid level should be checked and topped off. This will help avoid catastrophic failure. Make it a habit of visually inspecting the transmission every time the vehicle is in for an oil change or other service. This will help you catch any issues before they become severe.

Checking Differential Fluid

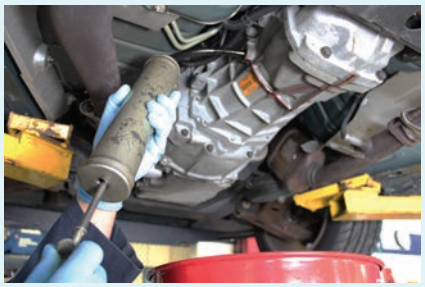
Checking and adjusting the differential/transfer case fluid level is similar to checking the transmission fluid level, but there are some differences. Examples include limited-slip and positraction assemblies, which require specially designed additives or fluid. Transfer cases may also require particular lubricants as specified by the manufacturer. Always check the service information for the vehicle you are working on.

Differentials and transfer cases generally have fill plugs that can be used when checking the fluid level in the same way a transmission does. However, they often do not have a drain plug. In these cases, either a specific bolt may need to be removed or a cover may need to be unbolted and removed. To check and adjust the differential fluid level, follow the steps in **SKILL DRILL 13-11**.

SKILL DRILL 13-10 Checking the Fluid Level of a Manual Transmission/Transaxle

1. Safely raise and support the vehicle on the lift so that it is level. Inspect the transmission for leaks. Remove the filler plug using the proper tool. Inspect the filler plug and fill hole for thread damage, and replace or repair if necessary.

2. If the gearbox fluid begins to run out as the filler plug is removed, let the gearbox fluid seek its own level before reinstalling the filler plug. The gearbox fluid level should be at the bottom of the fill plug hole.



3. If the fluid level is low, refill with the specified fluid, reinstall the filler plug, and wipe the area around the filler plug hole with a clean shop towel. Tighten the filler plug to the specified torque.

SKILL DRILL 13-11 Checking and Adjusting the Differential Fluid Level

1. Safely raise and support the vehicle. Inspect the differential and transfer case for leaks. Position a clean drain pan under the filler plug. Using the correct tool, remove the filler plug. Inspect the filler plug threads for damage, and replace if necessary.

2. If the fluid begins to run out as the filler plug is removed, let the fluid seek its own level before reinstalling the filler plug. The fluid level should be at the bottom of the filler plug hole.

3. If the fluid level is low, refill with the specified fluid, reinstall the filler plug, and wipe the area around the filler plug hole with a clean shop towel. Tighten the filler plug to the specified torque.

Checking for Fluid Leaks

The service bay should be clean and dry before driving the vehicle into the shop. This will help you locate any fluid leaks that may be present on the vehicle. Active leaks leave telltale drips or puddles on the clean floor, making it easier to identify what may be leaking. Vehicles have a variety of fluids that can leak. Some fluids come in a range of colors, such as red, which can be used for both automatic transmission fluid and antifreeze. Become familiar with each fluid's distinctive colors, feel, or smell:

- Brake fluid: May appear clear or light amber for DOT 3 and DOT 4. DOT 5 is usually purple, slightly slippery, and has an unpleasant, slightly acidic smell.
- Automatic transmission fluid and some manual transmission fluid: Normally reddish in color, although some manufacturers may use a clear or amber color; it is very slippery and oily and has an oily smell.
- Power steering fluid: Typically red if it uses automatic transmission fluid or clear in color if it uses power steering fluid.
- Coolant: Normally green, orange, or yellow in color; some manufacturers (e.g., General Motors) use a coolant that is red or light red. Others use

purple. It is slippery and has a sweet smell, like syrup.
- Engine oil: Clear, brown, or black in color; very slippery; and a bit thick, with an oily smell.
- Gear oil: Light brown in color, very slippery and thick (like syrup), with an oily smell.
- Gasoline: Clear in color, evaporates easily, and has a distinctive gas odor.
- Diesel: Dirty clear in color, thin, and has an oily smell.

Checking for leaks can be done as part of the under-vehicle inspection. The leaks are usually more visible on a warmed-up vehicle, although some coolant leaks appear only when the engine is cold. Discuss with the customer whether there are any unusual smells when the vehicle is running.

To check for leaks, drive the vehicle into a clean, well-lit work stall. Ideally, the stall will also have a lift so that the vehicle can be further inspected if a leak is suspected. Safely raise and support the vehicle. Use a flashlight or shop light to inspect the underside of the vehicle for any drips or wet areas. You may be able to identify the cause of the leak at this point.

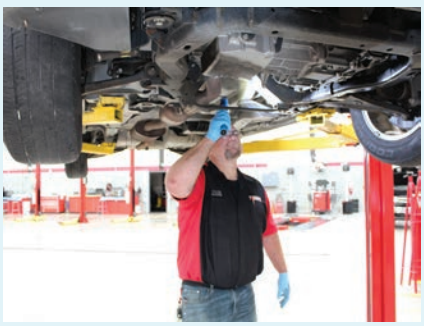
Try to identify the type of fluid that is leaking and the area from which it is leaking. Remember that gravity tends to pull any leaking fluids down. Always look toward the top of the wet area to help determine the source of the leak. If fluid leaks onto a moving part, it can be thrown a good distance, so check for a common source. Finally, a leak under pressure, such as coolant, can be sprayed a good distance from a small hole. Always look for a stream, using a good light to help identify the location of the leak. Finding the leak's source will tell you which component on the vehicle is likely leaking.

If the location of an engine leak cannot be determined with the engine off, start the engine and wait a few minutes. Then carefully look to see if any leaks appear. If so, carefully inspect the components to identify the location of the leak. Remember to stay away from moving or hot parts. If you still cannot see a leak, turn off the engine and inspect the engine again. Some leaks occur only shortly after the engine is shut down. To locate and identify fluid leaks, follow the steps in **SKILL DRILL 13-12**.

Steering and Suspension Inspection

The steering and suspension systems manage the movement of the wheels and body as the vehicle is being driven. All the joints, bushings, springs, and other components are subject to extreme forces, which cause them to wear. Worn parts cannot do their job like they should,

SKILL DRILL 13-12 Locating and Identifying Fluid Leaks



1. Safely raise and support the vehicle on a lift. Use a light to check for fluid leaks at any place that fluids can leak.

2. Once leaky fluid is found, follow it to its source.

3. If it is hard to identify exactly where the leak is coming from, you may need to make it leak by pressurizing the cooling system, applying the brakes, or operating the leaking system.

4. If you still cannot make it leak, try releasing the pressure or turning off the system. Sometimes leaks happen only when the system is shut off. This is a leak from the water pump weep hole.

FIGURE 13-49 Extremely worn steering components (tie-rod end) cannot hold the wheels in the correct position (removed for better view).

FIGURE 13-51 Torn dust boot and worn joint on this stabilizer link.

FIGURE 13-50 Wiggle one front wheel left and right while someone is feeling for play in each joint.

FIGURE 13-52 A torn CV boot found during the inspection.

so they need to be identified and replaced. When inspecting the steering system, look for wear and other types of damage (**FIGURE 13-49**). This can occur in tie rods and tie-rod ends, the idler arm, the pitman arm, and the steering gear or rack and pinion. The best way to locate worn steering components is when the vehicle is raised on a lift. Grab a front wheel at the 9 o'clock and 3 o'clock positions. Wiggle it left and right while someone inspects each of the steering joints for play (**FIGURE 13-50**). Do this for each wheel.

When inspecting the suspension system, some components are under very high load. You may not be able to move the component by hand to feel any play in it. In this case, you will visually inspect the appearance of the components. Many times there will be indications of worn parts, such as torn boots, or wear marks that indicate excessive movement. While inspecting the suspension system, also inspect the following:

- The dust boots for tears or displacement (**FIGURE 13-51**)
- The grease fittings that need to be greased, if any
- The shock absorbers for leaks
- The brake hoses for cracks and bulging
- The brake lines for kinks and rust
- The wheel bearings for excessive play

Drive Axles and Driveshafts Inspection

Drive axles and driveshafts are equipped with joints that can wear out, and the axles themselves can be bent or damaged. The following list describes what to look for when inspecting these components.

- Constant-velocity joints (**CV joints**) and dust boots: Look for cracked, torn, or leaking boots (**FIGURE 13-52**).
- The driveshaft: Check for any excess movement in driveshaft universal joints. Look for any dents or bends in the shaft.
- The differential, rear axle, and rear suspension area: The rear axle includes the differential and axle shafts. Look for leaks around the differential, and check the rear shock absorbers, leaf springs, brake hoses, and lines.

Engine, Transmission, and Exhaust Inspection

The engine, transmission, and exhaust have several components to be visually inspected. Inspect the following items as described:

- The engine: Look for torn or cracked motor mounts, coolant hoses, and belts (**FIGURE 13-53**).
- The transmission: Look for torn or cracked mounts as well as for faults or looseness in the clutch mechanism or shift linkage.
- The exhaust system: Check for signs of exhaust leaks, corrosion, or deterioration, including the exhaust hanger mounts. A good way to check the integrity of the exhaust pipe is to try to squeeze it along its length with a pair of arc joint pliers. If it is squishy, then it needs to be replaced. Check the condition of any heat shields.

Inspecting Other Items

There are two other items that should be considered when performing an under-vehicle inspection: the parking brake cables and the fuel tank. The parking brake cables are encased in a housing that attaches the parking brake lever or pedal to the rear brakes. Check for rusted, frozen, broken, or crushed cables.

The fuel tank is metal or plastic, depending on the vehicle. Inspection should include the filler tube and hose, the vent and fuel delivery lines, and the fuel tank straps and protective shields. The fuel tank must be secure and fuel lines inspected for damage or abrasion. To perform an under-vehicle inspection, follow the steps in **SKILL DRILL 13-13**.

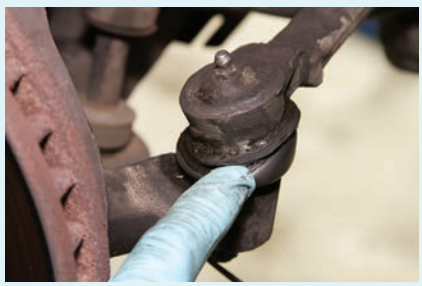
TECHNICIAN TIP

When checking the fuel tank, any odor of gasoline indicates a leak. Keep checking until you find it. It is not normal for modern-day vehicles to have any odor of gasoline.

FIGURE 13-53 Lower radiator hoses get neglected and need to be inspected.

SKILL DRILL 13-13 Performing an Under-Vehicle Inspection

1. Safely raise and secure the vehicle at a comfortable working height. Work systematically. Pay particular attention to any fluid leaks.



2. Check the steering parts. Grasp the front and rear of the tire and pivot it to detect wear in the steering components. Grasp the tire at the top and bottom and pivot it to detect movement in the wheel bearings or ball joints. Look for missing or torn rubber boots around the tie-rod ends and steering rack. Inspect the rack bushings and other rubber suspension bushings.

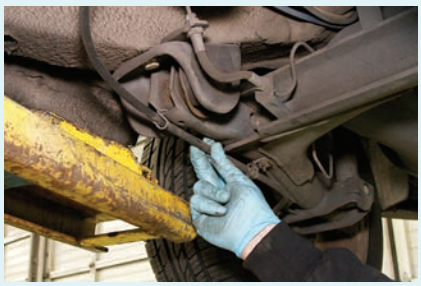
3. Inspect all four shock absorbers for signs of damage or leaks. Check the brake hoses and lines for signs of cracking, abrasions, or bulging.

SKILL DRILL 13-13 Performing an Under-Vehicle Inspection (*Continued*)

4. Check the front-wheel drive axles. On vehicles with front-wheel drive, examine the inner and outer CV boots for cracks or tears.

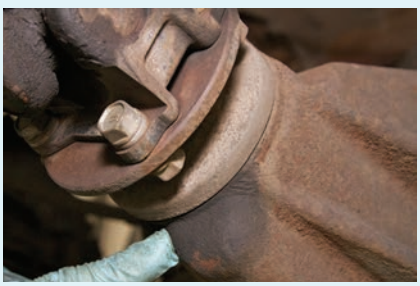
5. Check the transmission area. Trace and record the source of fluid leaks. Check the mount. With a manual transmission, check the clutch operating mechanism for damage. For an automatic transmission, check the shift linkage for any damage. If the transmission is electronically controlled, check the wiring for damage.

6. Check the exhaust system. Examine the catalytic converter, muffler, and resonator for signs of corrosion or deterioration. Inspect the heat shields. Check the tailpipe for corrosion, and check for damaged or missing hangers.



7. Check the parking brake cables. Inspect the parking brake cable to make sure that it is not frayed, damaged, or binding. Look for rusted or swollen cable housings. Pull on the cables, and check that the parking brake applies. Lubricate the cable if specified.

8. Check the driveshaft. On rear-wheel drive vehicles, inspect the driveshaft universal joints for signs of excess movement or rust. To check for wear, rotate the shaft and flange in opposite directions (there should be no up-and-down or side-to-side movement). On four-wheel drive vehicles, inspect the front driveshaft universals.



9. Check the differential and rear suspension area. Inspect the pinion shaft oil seal for any signs of leakage. Inspect the suspension mounting bushings for signs of deterioration or damage. If the vehicle is fitted with leaf springs, inspect them for any cracks or misalignment. Inspect the brake hoses for signs of cracking, abrasion, and bulges.

10. Check the fuel tank area. Check all the fuel lines and brake lines for signs of damage, abrasions, leaks, or rust.

Exterior Vehicle Inspections

LO 13-5

Perform exterior vehicle inspection.

A periodic inspection of the vehicle's exterior can prevent issues that may cause safety or operational concerns. It is much better to discover a problem such as a worn tire or broken taillight bulb during an inspection than when the car is broken down on the side of the road or the driver is pulled over by the police. A small percentage of owners check their vehicles for problems, but most depend on the service technician to do it for them. Any time the vehicle is in the shop for maintenance or repair, you should perform this inspection.

TECHNICIAN TIP

The customer or owner of the vehicle can perform an exterior inspection while washing the vehicle. Bad wiper blades, loose trim, and other items may be noticed that otherwise are not seen.

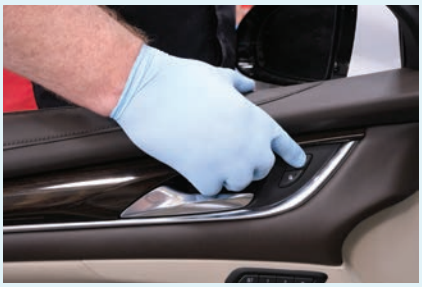
Performing a Visual Inspection of the Vehicle's Exterior

The vehicle exterior should be checked periodically for overall roadworthiness. The vehicle owner may perform this inspection themselves. More often, the service technician does it during oil changes. The inspection should also be made any time the vehicle is in the shop for service work. While doing this inspection, the technician should work in a systematic manner. Using an inspection sheet helps ensure that faults are not missed. To perform a visual inspection of the vehicle's exterior, follow the steps in **SKILL DRILL 13-14**.

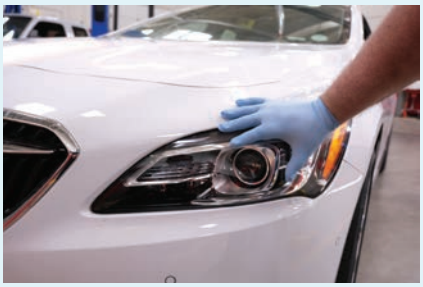
Checking Shock Absorbers

Shock absorbers and struts are located near each wheel. They dampen body movement from bumps in the road. A common reason for testing shock absorbers is unusual tire wear, such as tires having a cupped appearance. Also, the driver may complain of a soft or bouncy ride. In some cases, a shock absorber can bind up, creating a very stiff ride. If a vehicle has adjustable shock absorbers, make sure that the shock absorber adjustments are the same for the

SKILL DRILL 13-14 Performing a Visual Inspection of the Vehicle's Exterior



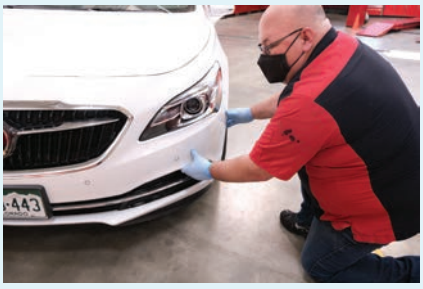
1. Prepare the vehicle. Park the vehicle in a well-lit area. Turn off the engine and unlock the doors and trunk or rear hatch.



2. Walk around the vehicle, observing any obvious items that need attention. Check the body condition.

3. Check exterior component and system operation.

4. Open and close doors to check that they are operating correctly.



5. Push and pull on the bumpers and fenders to ensure that they are secure.

6. Inspect the external mirrors to ensure that they are secure and not broken.

SKILL DRILL 13-15 Checking Shock Absorbers

1. Place your weight on a bumper, and begin to bounce the vehicle until it reaches its maximum amount of travel produced by your weight. Stop bouncing at the bottom of the bounce. If the shock absorbers are performing well, the vehicle will rebound once and then return to its original position.

2. Pay particular attention to the top strut mounting during the bounce test. Place your hand on top of the mounting during the bounce test. Any noise or looseness in the mounting could indicate the need to replace the mount.

3. Visually inspect the shock absorber mounting points for security and corrosion, and note any wet-looking patches on the sides of the shock absorbers. Slight dampness on the shock is typically normal, but a drip on the shock indicates leaking.

left- and right-hand sides. Some shock absorbers contain pressurized gas, which can leak out. This can cause uneven ride height and shock absorber performance issues.

Many of today's vehicles are equipped with a strut-type suspension instead of conventional shock absorbers. Testing either type of system involves the same procedure: a bounce test. Basically, while the vehicle is stationary, push up and down on a strong point at each corner of the vehicle (not the fenders, as they can be dented) several times. Watch how the vehicle responds after you release it. Typically, if you let go at the bottom, a good shock will allow the corner of the vehicle to rise and then settle back into position. On some vehicles with softer suspensions, it may allow the corner to rise, fall, and rise back into position. More oscillations than that would indicate worn shock absorbers.

Pay particular attention to the top strut mounting during the bounce test. Place your hand on top of the mounting during the bounce test. Any noise or movement in the mounting could indicate the need to replace the strut mount. Also, have someone turn the steering wheel from lock to lock while feeling and listening to the top strut mount. If you do feel movement or hear noise, report it to your supervisor. Visually inspect the shock absorber mounting points for security and corrosion. Note any wet-looking patches on the sides of the shock absorbers. A wet patch is a common indicator that the strut or shock absorber needs replacement because of a fluid leak. Slight dampness on the shock is typically normal, but drips on the shock are not normal and indicate excessive leaking. To check shock absorbers, follow the steps in **SKILL DRILL 13-15**.

Checking the Exterior Lights

The lighting system allows the driver to see the road when driving at night or in poor-visibility conditions. It also provides signals of your intentions to other drivers. These lights need to be checked periodically, as they do burn out on occasion. The exterior lighting system includes the following:

- Headlights
- Taillights
- Turn signals
- Side markers
- Brake lights
- License plate lights
- Backup lights

Some vehicles may have cornering lights, driving lights, or fog lights. Note that the rear lights may have three or more bulbs per side. Be sure to check that all of them are in working condition. To check the exterior lights, follow the steps in **SKILL DRILL 13-16**.

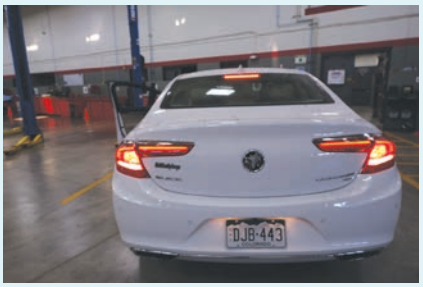
Checking and Replacing the Wiper Blades

The windshield wiper blades and arms are an important safety system on every vehicle. Many states with a vehicle inspection program fail a vehicle if the wiper blades are

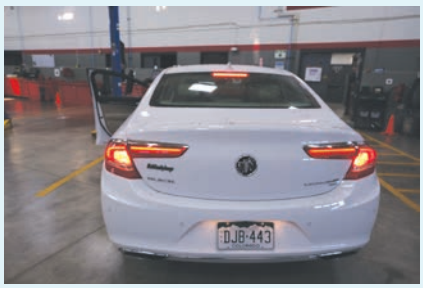
SKILL DRILL 13-16 Checking the Exterior Lights

1. Have someone sit in the vehicle, turn the ignition on, and switch the light switch to the park light position. Check that the taillights, side markers, and rear license plate lights come on.

2. Put the turn signal switch in the left-turn and then in the right-turn position, and check that the signals flash equally on each side.



3. With the ignition key on and the engine off, place the transmission in reverse and observe the backup lights.



4. Depress the brake pedal to make sure that the brake lights work. Check that the third (center) brake light works.

5. Make sure that the high and low headlight beams work correctly.

6. Make sure that the park lights, side markers, turn indicators, and daytime running lamps (if equipped) are all working correctly.

missing, torn, or worn out. The blades, along with the washer system, help the driver see clearly under all driving conditions.

The wiper blades should be checked as part of the exterior inspection. Usually, any wiper blade that is more than a year old is ready for replacement. This is especially true if the vehicle is parked outside. Both the blade and the wiper arm should be checked.

The wiper blade should be flexible and not torn. The wiper arm should flex at the hinge and be held firmly against the windshield by the wiper arm spring. The rear wiper blade and arm are checked in the same way.

Never operate the wipers when they are dry, as this may damage the blades or scratch the surface of the windshield. Never bend the arms to make better contact with the windshield. The arms are pretensioned by the manufacturer, and damage could result. If the arms seem to have lost their spring tension, obtain a suitable replacement. Many windshields have been broken during

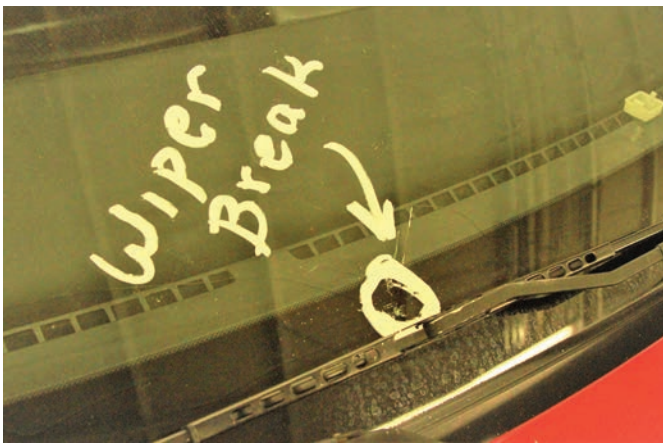


FIGURE 13-54 A windshield broken during wiper blade replacement.

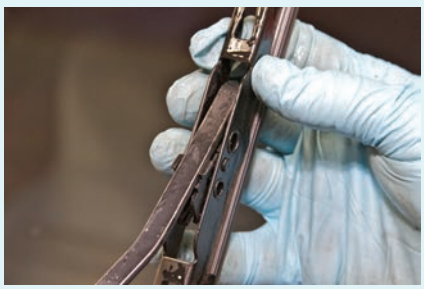
inspection or replacement of windshield wiper blades (**FIGURE 13-54**). The spring holds the wiper arm firmly against the windshield. If you drop the wiper arm while holding it away from the windshield, the spring will snap

SKILL DRILL 13-17 Checking and Replacing the Windshield Wiper Blades

1. Check the windshield wiper blades. Lift the wiper arm away from the windshield and inspect the condition of the blades. Look for damage or loss of resilience in the material.

2. Wet the windshield with a hose or with the washers and switch the wipers on. If the windshield is being wiped cleanly, do not replace the wiper blades. If the wiper blades are not wiping the glass evenly or are smearing, replace the blades.

3. Place a folded-up fender cover under the wiper blade you are working on to protect the windshield.



4. Remove the blade assembly.

5. Obtain and install the appropriate replacement blades.

6. Once the wiper blade is installed, test for proper operation.

it against the windshield. There is enough force to potentially break the windshield, especially if the wiper blade is removed from the arm. You can prevent a broken windshield by making sure that the arm is never allowed to slip. Another option is to place a folded-up fender cover on the windshield where the wiper arm would hit. To check and replace windshield wiper blades, follow the steps in **SKILL DRILL 13-17**.

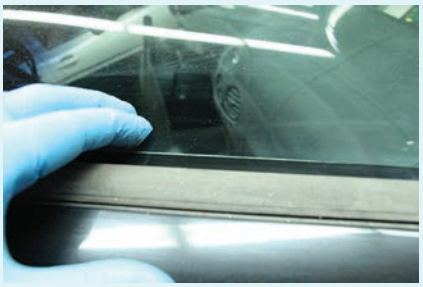
Windshield Inspection

The windshield should be inspected during the wiper blade inspection process. Scratched, scored, or pitted glass will not wipe clean, even with new blades. Windshields may become etched or pitted, causing the wipers to function poorly. This is a safety hazard and should be repaired. The glass in some cases may be polished to repair the condition, or it may have to be replaced. Some small chips or cracks can be repaired with special resins and tools. These services can be performed by an automotive glass repair service or at some collision repair shops. Large chips, or cracks longer than 3" (76.2 mm), may require replacement of the windshield. To inspect the windshield, follow the steps in **SKILL DRILL 13-18**.

SKILL DRILL 13-18 Inspecting the Windshield

1. Prepare the windshield. First, use glass cleaner to clean the windshield thoroughly.

2. Inspect the glass. Look closely at the surface of the glass. It may help to use a flashlight or trouble light at an angle while inspecting.



3. Look for any delamination conditions present.

WRAP-UP

Ready for Review

- Different levels of in-vehicle inspections include basic inspection, in-depth inspection, state safety inspection, certified used car inspection, and vehicle prepurchase inspection.
- An underhood fluid inspection should be performed at the manufacturer's recommended intervals and also prior to any long trip.
- Important fluids to be checked include engine oil, engine coolant, brake and clutch fluid, power steering fluid, automatic transmission/transaxle fluid, manual transmission/transaxle fluid, and windshield washer fluid.
- V-type and serpentine-type belts should be visually inspected whenever the hood is opened for service. The belts should be checked for cracks, oil soaking, glazing, tears, and bottoming out.
- When inspecting hoses, the engine should be cool.
- While inspecting the air filter, the air cleaner housing and ductwork should be checked for cracks or holes. Looking only at the top side of the filter will give you inaccurate information about the filter.
- An under-vehicle inspection should be carried out with the vehicle safely lifted on a hoist to get a feel for the overall condition of the vehicle.
- Under-vehicle inspection includes tire inspection, transfer case fluid level, fluid leaks, steering and suspension inspection, drive axles and driveshafts, engine, transmission, and exhaust.
- The vehicle exterior should be checked periodically.
- Shock absorbers, exterior lights, wiper blades, and the windshield should be inspected to prevent issues that may cause safety or operational concerns.

Key Terms

antilock brake system (ABS) A safety measure for the braking system that uses a computer to monitor the speed of each wheel and to control the hydraulic pressure to each wheel to prevent wheel lockup.

body control module (BCM) An onboard computer that controls many vehicle functions, including the vehicle interior and exterior lighting, horn, door locks, power seats, and windows.

CV joints A joint used to transmit torque through wider angles and without the change of velocity that occurs in U-joints.

diagnostic trouble code (DTC) A code logged by the electronic control module when electrical faults or system problems occur in commercial vehicle control systems.

diesel exhaust fluid (DEF) A mixture of urea and water that is injected into the exhaust system of a late-model, diesel-powered vehicle to reduce exhaust oxides of nitrogen emissions.

hygroscopic A property of a substance that causes it to attract and absorb moisture (water), as a sponge absorbs water.

instrument panel warning lamps Lamps that illuminate to warn a driver of a fault in a system.

malfunction indicator lamp (MIL) A dash light usually indicating the presence of a diagnostic trouble code or malfunction.

on-board diagnostics generation II (OBD-II) The second generation of on-board diagnostic systems, which have been in effect for all U.S. vehicles since 1996.

Review Questions

1. Most shops use inspection forms when inspecting vehicles because:
   - **a.** they slow the technician down.
   - **b.** they ensure a thorough and efficient inspection.
   - **c.** they don't have computers at the workstations.
   - **d.** they are required by insurance to complete them
2. If the malfunction indicator lamp (MIL) is illuminated while the vehicle is being operated:
   - **a.** shut off the engine immediately.
   - **b.** try revving the engine to see if the lamp goes off.
   - **c.** retrieve any diagnostic trouble codes (DTCs) with a scan tool.
   - **d.** step on the brake pedal firmly for at least 10 seconds.
3. When checking engine oil, it is important that the level be:
   - **a.** between the minimum and the maximum lines.
   - **b.** higher than the maximum line.
   - **c.** at least 0.25" (6 mm) below the minimum line.
   - **d.** not touching the bottom of the dipstick.
4. What is the main reason that brake fluid needs to be changed periodically?
   - **a.** The boiling point becomes too high.
   - **b.** It becomes too thin (viscosity).
   - **c.** It absorbs water (hygroscopic).
   - **d.** It ruins the brake lining.
5. When checking a serpentine belt for bottoming out:
   - **a.** use a straight edge across the belt ridges and measure the depth of the grooves.
   - **b.** twist the belt 90 degrees and see if cracks appear in the ridges.
   - **c.** measure the width of the belt to see if it has stretched too far.
   - **d.** use a small tool that should sit higher than the ridges in the belt.
6. A good way to test the integrity of exhaust pipes is to:
   - **a.** heat it up with a propane torch.
   - **b.** squeeze the pipe with arc joint pliers.
   - **c.** use a pry bar to see if the pipe will bend.
   - **d.** fill it with water and see if any leaks out.
7. How should you inspect an air filter to see if it needs to be replaced?
   - **a.** Wash it in the sink and see how water flows through it.
   - **b.** Use an air nozzle to blow air through it.
   - **c.** See if you can see light through it easily.
   - **d.** Air filters cannot be inspected; just replace them.
8. All the following systems should be checked as part of an under-vehicle inspection EXCEPT:
   - **a.** the steering system.
   - **b.** the suspension system.
   - **c.** the exhaust system.
   - **d.** the electrical system.
9. All the following statements are true EXCEPT:
   - **a.** the wiper blades should be flexible and not torn.
   - **b.** the wiper blades should be checked as part of an exterior inspection.
   - **c.** while checking, operate the wipers when they are dry.
   - **d.** never bend the arms to make better contact with the windshield.
10. Which of these is normally reddish in color?
    - **a.** Engine oil
    - **b.** Brake fluid
    - **c.** Automatic transmission fluid
    - **d.** Gear lube

ASE Technician A/Technician B-Style Questions

1. Technician A says that very wet fluid on struts or shocks is typically normal. Technician B says that shock absorbers can be tested with a bounce test. Who is correct?
   a. Technician A
   b. Technician B
   c. Both Technician A and Technician B
   d. Neither Technician A nor Technician B
2. Technician A says that improper handling of a windshield wiper can lead to a broken windshield. Technician B says that when testing wipers, if they wipe cleanly, replace them anyway. Who is correct?
   a. Technician A
   b. Technician B
   c. Both Technician A and Technician B
   d. Neither Technician A nor Technician B
3. Two technicians are discussing steering system inspection. Technician A says to wiggle the front tires side to side while feeling for play in the joints. Technician B says that there may be wear marks on the parts, indicating excessive movement. Who is correct?
   a. Technician A
   b. Technician B
   c. Both Technician A and Technician B
   d. Neither Technician A nor Technician B
4. Technician A says that when the engine is started, the amber antilock brake system (ABS) warning lamp should come on, stay on for a few seconds, and then go off, indicating a successfully completed preliminary self-check. Technician B says that if a fault is detected in the system, the warning lamp will blink five times. Who is correct?
   a. Technician A
   b. Technician B
   c. Both Technician A and Technician B
   d. Neither Technician A nor Technician B
5. Technician A says that coolant freeze protection can be measured with a hydrometer. Technician B says that coolant freeze protection can be measured with a refractometer. Who is correct?
   a. Technician A
   b. Technician B
   c. Both Technician A and Technician B
   d. Neither Technician A nor Technician B
6. Technician A says that operating the brake pedal can indicate a hydraulic brake problem. Technician B says that high-pitched scraping noises could indicate a worn brake lining. Who is correct?
   a. Technician A
   b. Technician B
   c. Both Technician A and Technician B
   d. Neither Technician A nor Technician B
7. Technician A says that the date code of the tire can be found on the tire sidewall. Technician B says that the vehicle's recommended tire pressure can be found on the tire sidewall. Who is correct?
   a. Technician A
   b. Technician B
   c. Both Technician A and Technician B
   d. Neither Technician A nor Technician B
8. Technician A says that the cabin air filter can be inspected similar to an engine air filter. Technician B says that the cabin air filter should be changed about every four to five years. Who is correct?
   a. Technician A
   b. Technician B
   c. Both Technician A and Technician B
   d. Neither Technician A nor Technician B
9. Technician A says that stretch-fit belts use a spring-loaded tensioner to keep them tight. Technician B says that a bottomed-out belt can be fixed by tightening it. Who is correct?
   a. Technician A
   b. Technician B
   c. Both Technician A and Technician B
   d. Neither Technician A nor Technician B
10. Technician A says that diesel exhaust fluid helps control oxides of nitrogen. Technician B says that diesel exhaust fluid should be replenished during oil changes. Who is correct?
    a. Technician A
    b. Technician B
    c. Both Technician A and Technician B
    d. Neither Technician A nor Technician B