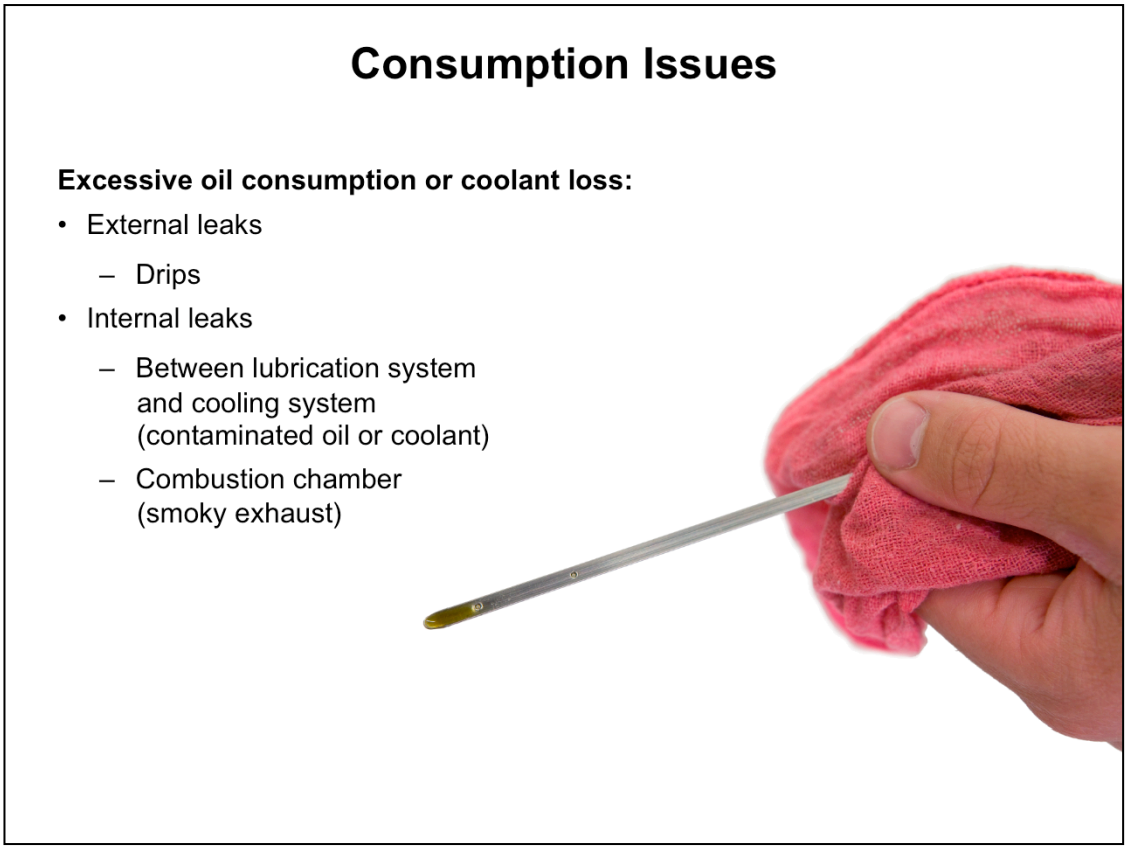
Section 10 Topics

General Engine Mechanical Diagnosis

- Consumption Issues
- Leak Inspection
- Exhaust Discoloration
- Noise and Vibration
- Compression Loss
- Diagnostic Tests
  - Diagnosis Theory Worksheet
  - Compression Test Worksheet
  - Cylinder Leakage Test Worksheet



Consumption Issues

Operating a vehicle while it's low on oil or coolant can result in serious engine damage. With extended oil change intervals and low viscosity oils, consumption issues or leaks can turn into very costly repairs if not identified and corrected in time. Therefore, it's important to always check the level of all fluids every time the vehicle is serviced and document low levels on the RO.

Complete the maintenance service interval as directed by the Repair Manual. Return the vehicle to the customer and have the customer return to the dealership at a predetermined mileage interval. Advise the customer not to adjust oil level during this process. When the customer returns, verify the oil level by checking the dipstick. It may be necessary to add oil to determine the quantity of oil consumed. Refer to the Warranty Manual for the allowable consumption rate and document your findings on the repair order.

Leak Inspection

Inspect for:

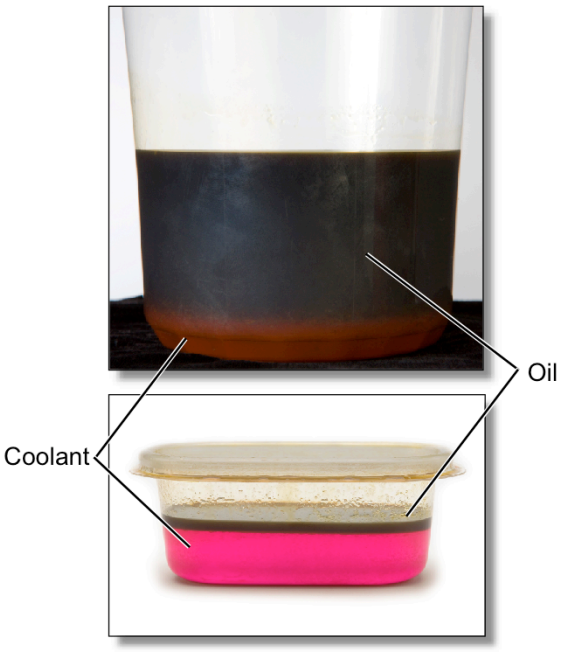
- Drips under vehicle
- Streaks or puddles on the engine
- Loose fittings or connections
- Leaking gaskets or seals

Use UV dye if necessary:

- Clean the engine
- Let engine run (or have customer bring vehicle back)
- Examine with ultraviolet light

Inspect oil and coolant:

- Oil and/or coolant cross contamination



Leak Inspection

When fluid levels are low, the first check should be for an external leak. External leaks can typically be diagnosed by visual inspection.

First, place the vehicle on a lift. Watch for leaks when the engine is cold and after it has reached operating temperature. If a leak is visible, but the source is unclear, thoroughly clean the area where fluid is observed and recheck.

If you're having difficulty pinpointing the source of an oil leak, it may be necessary to use a UV dye. Add the dye to the engine oil per the manufacturer's directions, then run the engine or return it to the customer and have the customer bring it back. Inspect the engine with an ultraviolet light to trace the source of the oil leak.

Exhaust Discoloration

Oil or coolant leaking into the combustion chamber can cause exhaust discoloration:

Fluid	Exhaust Discoloration	Possible Problem Area
Oil	Grayish-blue smoke	Rings, head gasket, valve guides or oil seals
Coolant	White smoke (sometimes with a sweet smell)	Head gasket

Note: Black smoke indicates an excessively rich fuel mixture

Hint: To find the cylinder that is smoking, examine the spark plugs:

- Oily deposit indicates oil leaking into the combustion chamber
- Grayish-white deposit indicates coolant leaking into the combustion chamber

Exhaust Discoloration

Normal exhaust gases go unnoticed most of the time and for good reason. Seasoned technicians, however, know that the condition of the engine can often be evaluated by the color of the exhaust.

Smoky or discolored exhaust gases are clear indicators of failures in combustion chamber sealing. If anything other than air or fuel enter the combustion chamber, exhaust gases typically are the tell-tale sign there's something wrong.

When burned in the combustion chamber, oil typically produces a grayish-blue exhaust smoke. Often, technicians mistakenly confuse black smoke for oil but this is an indication of a rich fuel mixture, which can be considered normal under certain operating conditions.

When coolant is burned, it creates a white smoke that sometimes smells sweet. Don't confuse this with exhaust condensation, which is normal when the vehicle has not reached normal operating conditions.

When investigating exhaust discoloration complaints it is a good idea to look at the spark plug to identify which cylinders are involved. The spark plug is the only component that resides in the combustion chamber that can be easily removed for inspection. Signs of black oily residues on the spark plug indicate oil is entering the combustion chamber. Gray-white deposits indicate coolant is being burned.

Noise and Vibration

- Eliminate accessory noises by removing belts
- Use a mechanic's stethoscope to determine where the noise is loudest.
  - Top end vs. bottom end
  - Bank 1 vs. bank 2
  - Front vs. rear of engine
- What type of noise is it?
  - Lifter
  - VVT-I
  - Piston slap
  - Rod knock
  - Spark knock

Noise and Vibration

In modern Toyota engines, noise or vibration concerns are slightly more difficult to pinpoint due to the materials used and the greater number of parts. Noise diagnosis is a skill that only comes with experience and seasoned technicians take great pride in this fact.

When diagnosing engine noises, you can follow these basic steps until you fine tune your own diagnostic ear.

Component removal:

- Remove accessory equipment temporarily, if the noise is no longer present it is possible the noise is not in the engine.
- Remember to remove components one at a time (if possible).
- Only remove equipment that will not cause damage to the engine.

Pinpoint noise location:

- Aluminum engines are very good at transferring noises originating in one part of the engine to a different area.
- Use a stethoscope (or use a long screwdriver as a stethoscope) to isolate the loudest area
- Load or unload the engine to make the noise more pronounced.

Compression Loss

Causes

Loss of combustion chamber seal:

- Rings
- Valve timing
- Bent or broken valve
- Burn hole in a piston or valve
- Head gasket

Restricted airflow:

- Clogged intake
- Restricted exhaust

Diagnostic Tests

- Cylinder Balance Test
- Cylinder Compression Test
- Cylinder Leakage Test

Compression Loss

Diagnosing a misfire or no-start concern should start with checking the ability of the engine to pump and compress the air/fuel charge. Since the combustion chamber is hard to visually inspect we must rely on several static and dynamic tests to evaluate the components involved in sealing the combustion chamber. The tests described in the following pages are relatively easy to perform and can quickly evaluate the efficiency of the engine.

Cylinder Balance Test

How It Works

- Engine RPM changes when one cylinder is disabled
- If one cylinder is not providing power, RPM will not change when it is disabled

Test Procedure

- Warm up the engine
- Use active test to cut fuel to each cylinder one at a time and record RPM
- Let engine run on all cylinders for 1 minute between each cylinder test

Cylinder Balance Test

One way to find a cylinder that is losing compression or has some other issue that prevents it from contributing power is to perform a cylinder balance test.

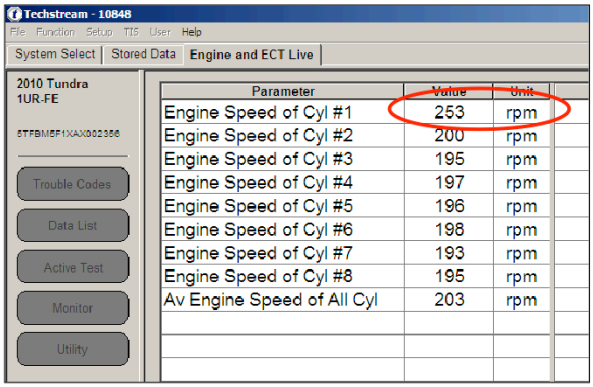
In this test, you disable each cylinder one at a time while observing RPM. When a good cylinder is disabled, the RPM will change. If any cylinder is already not working, disabling it will have little effect on the RPM.

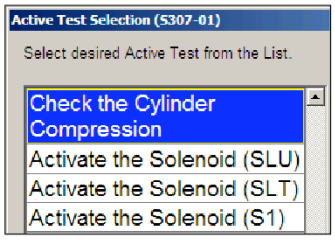
Ideally, the decrease in RPM should be roughly the same for all cylinders. If the RPM drop is noticeably less for any cylinder, then that cylinder is contributing less power than the others and should be diagnosed.

The cylinder balance test is not very effective in late model Toyota engines, however, because the ECM is programmed to adjust idle to compensate for a weak cylinder. Therefore the change in RPM may not be significant enough to tell you much about each cylinder's performance.

Techstream Compression Test

- Techstream can determine relative cylinder compression without a cylinder compression pressure gauge
- Techstream measures the engine RPM during each cylinder's compression stroke
- The piston moves faster during the compression stroke when the compression is low





Note: The Techstream Compression Test procedure is in the Repair Manual under SFI System > Data List / Active Test.

Techstream Compression Test

When you're set up to perform this Techstream Active Test, display the Data List for engine compression as shown above. The list will initially display 51199 RPM for each cylinder indicating Techstream has not yet calculated an actual value.

Next, begin cranking the engine for 20 to 45 seconds. (Techstream will keep the engine from starting.) When Techstream has calculated the RPM values, they will display as shown above.

When cranking stops, the RPM values will revert to 51199, so you will have to take a snapshot as soon as the RPM values appear in order to preserve and analyze them.

If any cylinder has a noticeably higher RPM than all the others, it means its compression is low and requires further diagnosis.

Compression Gauge Test

Basic Procedure

- Disable the engine so it will not start
- Remove the spark plug from the cylinder to be tested and attach a cylinder pressure test gauge
- Crank for 10 seconds and record the highest pressure reading
- All cylinders should be approximately equal and within Repair Manual specifications*

*Specifications can range from 140 to 210 psi

Standard Compression Test

Before Techstream, a cylinder compression test was performed with a compression gauge.

In this type of test, the cylinder's actual compression pressure is measured by installing a pressure gauge in place of the spark plug. After disabling the engine so it will not start, crank the engine for 10 seconds, and then record the highest pressure reading displayed on the gauge.

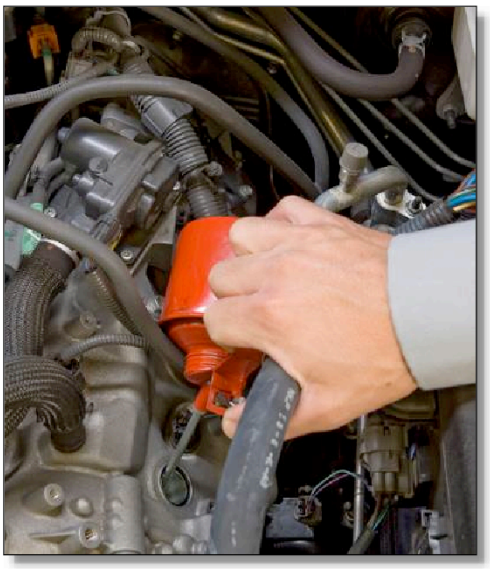
Compare the pressure readings between the cylinders. They should all be approximately equal. Also compare the pressure readings to the Repair Manual specifications.

Wet Compression Test

If one cylinder's compression is lower than the others, perform a Wet Compression Test:

- Remove the spark plug and squirt a little SAE 30 oil in the cylinder
- Repeat the compression test
- If the cylinder's compression improves, the problem is the piston rings
  - Compression improves because the oil temporarily seals the piston rings
- If the compression does not improve, the problem is with the valves

Note: This test is not in the Repair Manual but is recognized as an industry standard test.



Wet Compression Test

If the conventional compression test determines that one or more cylinders are below specification, then further investigation will narrow your list of potential causes and aid in your consult with the ASM.

One way to determine the cause for low compression is a wet compression test. The wet compression test is similar to a conventional compression test except you squirt a small amount of oil into the combustion chamber first. This oil forms a temporary seal around the piston to cylinder wall.

- If compression pressure increases with the addition of the oil, the most likely cause for low compression is worn rings.
- If compression pressures remains low, the cause may be related to valves and further testing will be required.

CAUTION Only use a small amount of oil. Too much oil may potentially cause damage.

Cylinder Leakage Test

How it Works

- Indentifies poorly sealed combustion chamber by measuring pressure loss
- The cylinder is set at TDC on the compression stroke so that both valves are closed
- A leak-down tester is connected to the spark plug hole
- Pressure loss is shown on the gauge

Problem Identification

To determine the problem, find where you can hear air escaping.

Location of Escaping Air	Possible Faulty Component
Exhaust pipe	Exhaust valve
Throttle body	Intake valve
Cylinder head, radiator	Cracked block, head gasket
PCV, oil filler cap	Rings

Note: This test is not in the Repair Manual but is recognized as an industry standard test.

Cylinder Leakage Test

Although conventional compression gauges can determine cylinders with lower than normal sealing, they cannot determine which internal component has failed inside the combustion chamber. When diagnosing a mechanical failure, you as technicians may save yourself a great deal of work if you know how to isolate the root cause without tearing an engine down for visual inspection. One method is by using a cylinder leakage tester.

A cylinder leakage tester regulates air pressure into the combustion chamber (while at TDC compression) as the technician listens for leaks. If significant leakage is evident, escaping air from the combustion chamber can be heard leaking from the defective component. If air is found to be leaking into the exhaust system this would indicate a possible burnt or bent exhaust valve. If air bubbles are found in the coolant system this might indicate a possible head gasket failure or cracked water jacket.

By using a cylinder leakage tester to narrow the potential type of engine repair needed, you can improve management of customer expectations and speed up the pinpoint diagnosis and repair.

Worksheets

Compression Test

In this worksheet you will:

- Use Techstream to perform a relative compression test
- Perform engine cylinder compression test; determine necessary action

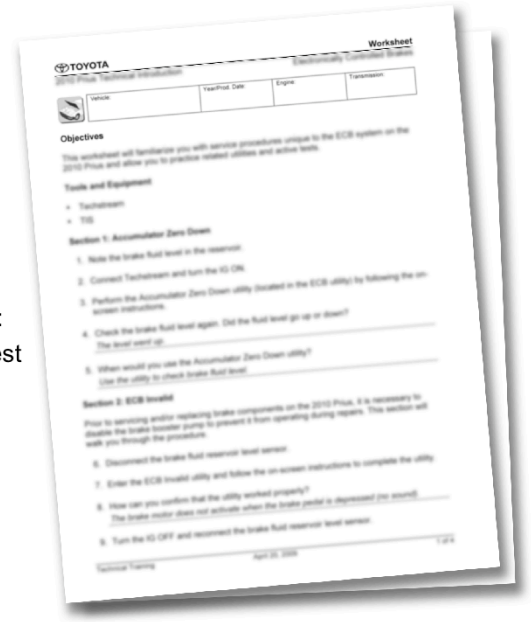
Cylinder Leakage Test

In this worksheet you will demonstrate :

- How to perform a cylinder leakage test
- How to isolate a cylinder leak

Diagnosis Theory

In this worksheet you will demonstrate your understanding of general engine mechanical diagnosis principles.


TOYOTA

Worksheet

Vehicle | Year/Prod. Date | Engine | Transmission

Objectives

Tools and Equipment

- Techstream
- TIS

Section 1: Accumulator Zero Down

1. Note the brake fluid level in the reservoir.
2. Connect Techstream and turn the IG ON.
3. Perform the Accumulator Zero Down utility (located in the ECB utility) by following the on-screen instructions.
4. Check the brake fluid level again. Did the fluid level go up or down?
   The level went up.
5. When would you use the Accumulator Zero Down utility?
   Use the utility to check brake fluid level.

Section 2: ECB Invalid

Prior to servicing and/or replacing brake components on the 2010 Prius, it is necessary to disable the brake booster pump to prevent it from operating during repairs. This section will walk you through the procedure.

6. Disconnect the brake fluid reservoir level sensor.
7. Enter the ECB invalid utility and follow the on-screen instructions to complete the utility.
8. How can you confirm that the utility worked properly?
   The brake motor does not activate when the brake pedal is depressed (no sound).
9. Turn the IG OFF and reconnect the brake fluid reservoir level sensor.

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Use this space to write any questions you may have for your instructor.

NOTES: