MODULE CONTENT

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| Unit of Competency | **DIAGNOSE AND REPAIR STARTING SYSTEM** |
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| Module Title | **DIAGNOSING AND REPAIRING STARTING SYSTEM** |
| Module Descriptor | This unit covers the knowledge, skills and attitudes required to diagnose and repair starting system and its component. |
| Nominal Duration | **hours** |
| Summary of the Learning Outcomes: | |
| Upon completion of this module the student must be able to: | |
| LO1. Prepare to diagnose and repair starting system | |
| LO2. Diagnose starting system | |
| LO3. Repair starting system | |
| LO4. Complete work processes | |

**LEARNING EXPERIENCES**

**LEARNING OUTCOMES NO. 2**

**DIAGNOSE STARTING SYSTEM**

| **Learning Activities** | **Special Instructions** |
| --- | --- |
| Read Information Sheet 3.1-1 Diagnose starting system | If you have some problem with the content of the information sheet don’t hesitate to approach your Trainer.  If you feel that you are now knowledgeable on the content of the information sheet, you can now answer the self-check provided in the module. |
| Answer Self-Check 3.1-1 on Diagnose starting system | Try to answer the Self-check without looking at the Answer Key  Compare your answer to Answer Key 3.1-1 |
| Observe Trainer’s demonstration on Task Sheet 3.1-1 on Diagnose starting system | Listen carefully and attentively so that you may be able to perform a task correctly  Ask questions if are in doubt for clarification |
| Perform the Task Sheet 3.1-1 on Diagnose starting system | Remember the step-by-step procedure of the Diagnose starting system |
| Evaluate the performance using the Performance Criteria Checklist 3.1-1 | Repeat the task in case fail to meet the criteria |

**INFORMATION SHEET 1.1-1**

**DIAGNOSE STARTING SYSTEM**

**Learning Objectives:**

After reading this **Information Sheet**, you must be able to:

1. Inspection of starter motor components operation
2. Repair and replacement of starter motor
3. Inspection and repair of starting system circuit

**STARTING SYSTEM**

STARTING SYSTEM TESTING

As mentioned earlier, the starter motor is a special type of electrical mote designed for intermitted use only. During testing, it should never e operated for more than 15 seconds without resting for 2 minutes in between operation cycles to allow it to cool.

Preliminary Checks

The cranking output obtained from the motor is affected by the condition and charge of the battery, the circuit’s wiring, and the engine’s cranking requirement.

The battery should be checked and charged as needed before testing the starting system.

Check the wiring and cables for clean, tight connections. Loose or dirty connections will cause excessive voltage drops. Cables can be corroded by battery acid, and contact with the engine parts and other metal surfaces can fray the cable insulation. Frayed insulation can cause a dead short that can seriously damage come of the electrical units of the vehicle.

Cables should also be check to make they are not undersizes (too small a gauge) or too long. Both conditions can limit the amount of current delivered to the starter motor.

When checking cables and wiring, always check any fusible links in the wiring. Most late-model vehicles are equipped with maxi-fuses in place of the fusible links. Both should be checked during the any routine starting system inspection. When a maxi-fuse or fusible link has failed, always troubleshoot the system and locate the cause before replacing the fuse or link.

Make certain the engine is filled with the proper weight oil as recommended by the vehicle manufacturer. Heavier-than-specified oil when coupled with low operating temperatures can drastically lower cranking speed to the point where the engine does not start and excessively high current is drawn by the starter.

Check the ignition switch for loose mounting, damaged wiring, sticking contacts, and loose connections. Check the wiring and mounting of the safety switch, if so equipped, and make certain the switch is properly adjusted. Check the mounting, wiring, and connections of the magnetic switch and starter motor. Also, be sure the starter pinion is properly adjusted.

Safety Precautions

Almost all starting system tests must be performed while the starter motor is cranking the engine. However, the engine must not start and run during the test or the readings will be inaccurate

To prevent the engine from starting, the ignition switch can be bypassed with a remote starter switch that allows current to flow to the starting system but not to the ignition system.

During testing, be sure the transmission is out of gear during cranking and the parking brake is set. When servicing the battery, always follow safety precautions. Always disconnect the battery ground cable before making or breaking connections at the system’s relay, solenoid, or starter motor.

Troubleshooting Procedures

A systematic troubleshooting procedure is essential when servicing the starting system. Consider the fact that nearly 80% of starters returned a defective on warranty claims work perfectly when tested. This is often the result of poor or incomplete diagnosis of the starting and related charging systems. Testing the starting system can be divided into area tests, which check voltage and current in the entire system, and more detailed pinpoint tests, which target one particular component or segment of the wiring circuit.

Starter Solenoid Problems

A Typical symptom of solenoid problems is the presence of a clicking noise when the ignition is turned to the start position. The clicking noise is caused by the solenoid’s plunger moving back and forth. Normally the plunger moves to the battery contacts and is held there by a magnetic field until the ignition switch is moved from the start position.

In order for the solenoid’s plunger to move enough to complete the starter motor circuit and remain in that position, a strong magnetic field must be present around the solenoid’s windings. The strength of the magnetic field depends on the current flowing through the windings. Therefore anything that would reduce current flow would affect the operation of the solenoid. Common causes of the clicking are low battery voltage, low voltage available to the solenoid, or an open in the hold-in winding.

Checking voltage at the battery and to the solenoid will help you identify the cause of the problem. If the solenoid is bad, it can be replaced as a unit on some starter motors or replaced with the starter motor on the designs.

Starting Safety Switches

Safety switches can be checked with a voltmeter or an ohmmeter. When the transmission is placed in park or neutral or when the clutch pedal is depressed, the switch should be closed. In other gear positions and when the clutch pedal is released, the switch should be open. Often these switches just need to be properly adjusted to correct their action. This is not possible on all vehicles. If adjustment does not correct the problem, the switch should be replaced.

Battery Load Test

A slow cranking engine often caused by insufficient current from the battery other problem such as incorrect ignition timing. The battery must be able to crank the engine under all load battery load test before checking the starting systems.

Cranking Voltage Test

The cranking voltage test measures the available voltage to the starter during cranking. To perform the test, disable the ignition or use a remote starter switch to bypass the ignition switch. Normally, the remote starter switch leads are connected to the positive terminal of the battery and the starter terminal of the solenoid or relay (Figure 18-22). Refer to the service manual for specific instructions on the model car area being tested. Connect the voltmeter’s negative lead to a good chassis ground. Connect the voltmeter’s positive lead to the starter motor feed at the relay or solenoid. Activate the starter motor and observe the voltage reading. Compare the reading to the specifications given in the service manual. Normally, 9.6 volts is the minimum required.

Figure 18-22 Using a remote starter switch to bypass the control circuit and ignition system.

Test Conclusions If the reading above specifications but the starter motor still cranks poorly, the starter motor is faulty. If the voltage reading is lower than the specifications, a cranking current test and circuit resistance test should be performed to determine if the problem is caused by high resistance in the starter circuit or an engine problem.

Cranking Current Test

The crank current test measures the amount of current the starter circuit draws to crank the engine. Knowing the amount of current draw helps to identify the cause of starter system problems.

Nearly all starter current testers use an inductive pickup (Figure 18-23) to measure the current draw. However, some earlier models were equipped with an ammeter that needed to be connected in series with the battery.

Figure 18-23 Connecting the test leads of a typical charging/starting/battery tester.

To conduct the cranking current test, connect a remote starter switch or disable the ignition prior to the testing. Follow the instructions given with the tester when connected to the leads. Crank the engine for no more than 15 seconds. Observe the voltmeter. If the voltage drops below 9.6 volts, a problem is indicated. Also, watch the ammeter and compare the reading to specifications.

Table 18-1 summarizes the most probable causes of too low or high starter motor current draw. If the problem appears to be caused by excessive resistance in the system, conduct an insulated circuit resistance test.

TABLE 18-1 RESULT OF CRANKING CURRENT

TESTING

Problem Possible Cause

Low current draw Undercharged or defective battery.

Excessive resistance in circuit due to

faulty components or connections.

High current draw Short in starter motor.

Mechanical resistance due to

binding engine or starter system

component failure or misalignment.

Insulated Circuit Resistance Test

The complete starter circuit is made up of the insulated circuit and the ground circuit. The insulated circuit includes all of the high current cables and connections from the battery to the starter motor.

To test the insulated circuit for high resistance, disable the ignition or bypass the ignition switch with a remote starter switch. Connect the positive (+) lead of the voltmeter to the battery’s positive (+) terminal post or nut. By connecting the lead to the cable, the point of high resistance (cable-to-post connection) may be bypassed. Connect the negative (-) lead of the voltmeter to the starter terminal at the solenoid or relay. Crank the engine and record the voltmeter reading. If the reading is within specifications (usually 0.2 to 0.6 volt drop), the insulated circuit does not have excessive resistance. Proceed to the ground circuit resistance test outlined in the next section. If the reading indicates a voltage loss above specifications, move the negative lead of the tester progressively closer to the battery, cranking the engine at each test point. Normally, a voltage drop of 0.1 volt is the maximum allowed across a length of cable.

Photo Sequence 13 goes through the correct procedure for conduction a voltage drop test on a typical starter circuit.

Test Conclusion When excessive drop is observed, the trouble is located between that point and the preceding point tested. It is either a damaged cable or poor connection, an undersized wire, or possibly a bad contact assembly within the solenoid. Repair or replace any damages wiring or faulty connections. Refer to Table 18-2 to find the maximum allowable voltage drops for the starter circuit.

TABLE 18-2 MAXIMUM VOLTAGE DROPS

Each large cable 0.1 volt

Each connection 0.1 volt

Each small wire 0.2 volt

Starter relay 0.3 volt

Starter Relay Bypass Test

The starter relay bypass test is a simple way to determine if the relay is operational. First, disable the ignition. Connect a heavy jumper cable between the battery’s positive (+) terminal and the starter relay’s starter terminal. This bypasses the relay. When the connection is made, the engine should crank.

Test Conclusions If the engine cranks with the jumper installed and did not before the relay was bypassed, the starter relay is defective and should be replaced.

Ground Circuit Resistance Test

The ground circuit provides the return path to the battery for the current supplied to the starter by the insulated circuit. This circuit includes the starter-to-engine, engine-to-chassis, and chassis-to-battery ground terminal connections.

To test the ground circuit for high resistance, disable the ignition, or bypass the ignition switch with a remote starter switch. Refer to Figure 18-24 for the proper test connection. Crank the engine and record the voltmeter reading.

Figure 18-24 The setup for checking voltage drop across the ground circuit.

Test Conclusions Good results would be less than a 0.2 volt drop for a 12-volt system. A voltage drop in excess of this indicates the presence of a poor ground circuit connection, resulting from a loose starter motor bolt, a poor battery ground terminal post connector, or a damaged or undersized ground system wire from the battery to the engine block. Isolate the cause of excessive voltage drop in the same manner as recommended in the insulated circuit resistance test by moving the positive (+) voltmeter lead progressively closer to the battery. If the ground circuit tests out satisfactorily and a starter problem exists, move on to the control circuit test.

Voltage Drop Test of the Control Circuit

The control circuit test examines all the wiring and components used to control the magnetic switch, whether it is a relay, a solenoid acting as a relay, or a starter motor mounted solenoid.

High resistance in the solenoid switch circuit reduces current flow through the solenoid windings, which can cause improper function of the solenoid. In some cases functioning of the solenoid switch general results in the burning of the solenoid switch contacts, causing high resistance in the starter motor circuit.

Check the vehicle wiring diagram, if possible, to identify all control circuit components. These normally include the ignition switch, safety switch, the starter solenoid winding, or a separate relay.

To perform the test, disable the ignition system. Connect the positive meter lead to the battery’s positive terminal and the negative meter lead to the starter switch terminal solenoid or relay. Crank the engine and record the voltmeter reading.

Test Conclusions Generally, good results would be less than 0.5 volt, indicating that the circuit condition is good. If the voltage reading exceeds 0.5 volt, it is usually an indication of excessive resistance. However, on certain vehicles a slightly higher voltage loss may be normal.

Identify the point of high resistance by moving the negative test lead back to the battery’s positive terminal, eliminating one wire or component at a time.

A reading of more than 0.1 volt across any one wire or switch is usually an indicator of trouble. If a high reading is obtained across the safety switch used on an automatic transmission, check the adjustment of the switch according to the manufacturer’s service manual. Clutch operated safety switches cannot be adjusted. They must be replaced.

Test Starter Drive Components

This test detects a slipping starter drive without removing the starter from the vehicle. First, disable the ignition system or bypass the ignition switch with a remote starter switch. Turn the ignition switch to start and hold it in this position for several seconds. Repeat the procedure at least three times to detect an intermittent condition.

Test Conclusions If the starter cranks the engine smoothly, that is an indication that the starter drive is functioning properly. to If the engine stops cranking and the starter spins noisily at high speed, the drive is slipping and should be replaced.

If the drive is not slipping, but the engine is not being cranked, inspect the flywheel for missing or damaged teeth. Remove the starter from the vehicle and check its drive components. Inspect the pinion gear teeth for wear and damage. Test the overrunning clutch should turn freely in one direction, but not in the other. A bad clutch will turn freely in the overrun direction or not at all. If a drive locks up, it can destroy the starter to spin at more than 15 times engine speed.

The weak point in the movable pole starter is the pole shoe that pulls in toward the armature to engage the starter. This starter requires a minimum of 10.5 volts and high amperes to operate. Otherwise, it simply clicks and loses does not engage.

As a movable pole starter wears, the pivot bushing sometimes hangs up and prevents the movable poles shoe from being pulled down. When this happens, the starter motor will not spin and the drive will not engage with the flywheel.

A similar problem can occur on solenoid-actuated starters. If the solenoid is too weak to overcome the force of the return springs, the starter does not operate.