Vehicle Inspection

It is important to perform a thorough inspection of the test vehicle before running Comprehensive tests. Comprehensive testing starts with a visual check procedure. In addition to that procedure, however, the operator may want to repair any minor problems that would make it difficult to perform the tests (obviously bad wires, vacuum lines, fan belts, etc.). Use the expanded as a guide to a more thorough visual inspection.

Battery

- Check for loose hold-downs.
- Check electrolyte level; fill if necessary.
- Check cable connections for good contact, cleanliness, excessive corrosion. Clean and tighten as needed.
- Check cables for fraying, breaks, poor insulation.
- Check battery case for cracks.

Belts

- Check fan belt for cracks, impending breaks, proper tension; tighten or fix as needed.
- Check all other drive belts in the same way and make necessary corrections.

Fluid Levels

- Check engine oil level and add if necessary.
- Check transmission fluid; add if needed.
- Also check other fluid levels in power steering, brake system, windshield washer, etc.

Filters, Emission Control Devices

- Check air filters (carburetor, air pump, crankcase breathers), PCV, air injection, other emission devices, vacuum control valves, etc.

Electrical Connections

- Check all wiring (both low and high tension) for cleanliness, tightness, seating, general condition.

Exhaust System

- Quickly check resonator, muffler, exhaust pipes, clamps, tail pipes and catalytic converter for breaks, leaks.

Hoses

- Check all hoses (PCV, heater, radiator, power steering, vacuum, fuel, evaporative control, etc.) for general condition, leaks, cracks, tightness, proper connection, etc.

Radiator and Cap

- Check coolant level; fill as needed.
- Check cap for condition.

Comprehensive: Begin Testing

Leads Required:

Connect all appropriate leads, as described under "Test Leads" in the "Introduction" section.

FOR D.I.S. VEHICLES: The analyzer will display polarities for D.I.S. secondary leads during DIS Setup at the beginning of D.I.S. Comprehensive tests.

Select Test

1. When the Master Menu appears, press [2] to select "AUTOMATIC TESTING.

2. Select the appropriate Comprehensive test (see Figure 96). Press:

   [1] **COMPREHENSIVE** - for vehicles with conventional, distributor-type ignition systems. Follow the operating instructions in this section, but just skip the pages that say "DIS" at the top.

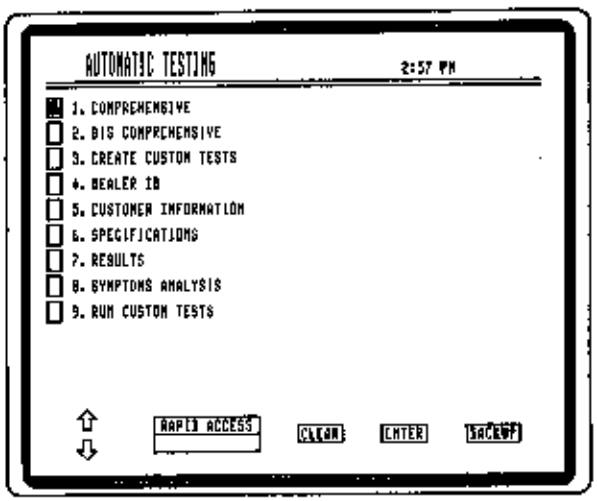

Figure 96

   [2] **DIS COMPREHENSIVE** - for vehicles with D.I.S. — Direct Ignition System. Follow the operating instructions in this section, but just skip the pages that say "CONV" at the top.

3. Follow the screen prompts (see Figure 97) and set the parking brake and place transmission in "PARK" or, "NEUTRAL" (manual transmissions only). Turn off all lights and accessories. Make sure the ignition key is "OFF."

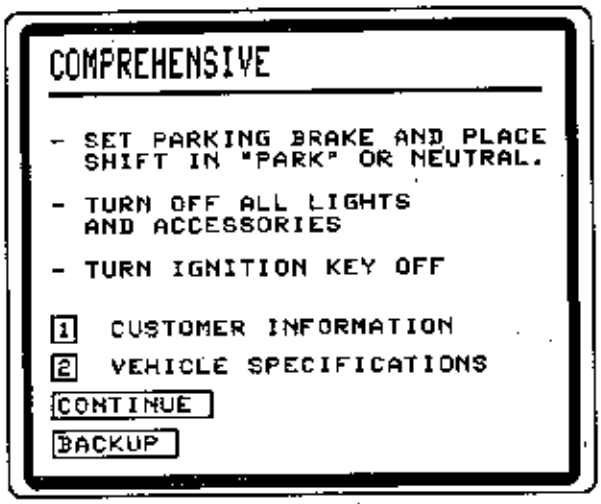

Figure 97

4. Press [1] to enter Customer Information. For detailed instructions, see the "Customer Information" section.

5. Press [2] to enter Vehicle Specifications. Press the appropriate number on the display screen (see Figure 98) and enter the required specifications. For detailed information, see the "Specifications" section.

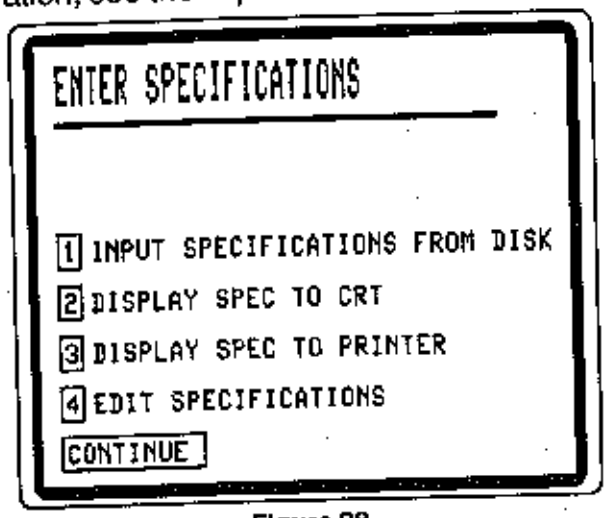

Figure 98

NOTE: If there is any difference between the emissions control decal information found "ON" the vehicle and the disk-based specifications, use the Edit Specifications screen to enter the emissions decal information.

It is not necessary to re-enter specifications when re-testing a vehicle that has just been tested.

After the pages of specifications have been displayed on the screen, select "Display Specs to Printer" if the optional printer is installed. The analyzer will print out a reference copy for use during testing.

6. Press [CONTINUE] when finished.

Comprehensive: Setup - D.I.S.

1. In D.I.S. Comprehensive testing, the Direct Ignition Set-Up screen will appear (see Figure 99). Press the number corresponding to the vehicle model being tested. Press [6] to select "OTHER" if the model does not appear on the list, and see the note on the following page.

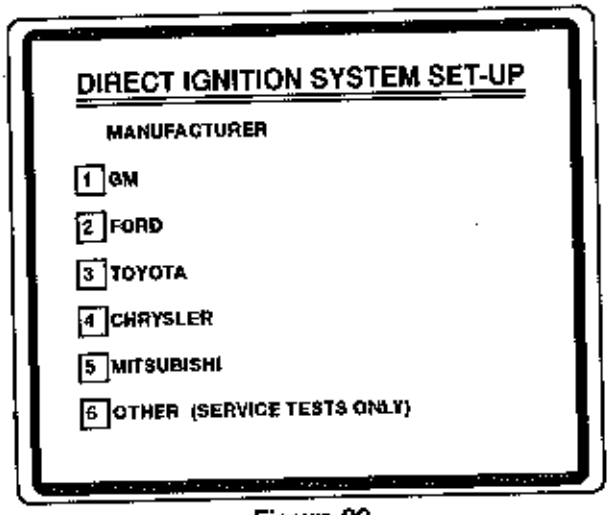

Figure 99

Continued...

2. The next screen lists engine types and their "polarity set-ups" (see Figure 100). A "polarity set-up" indicates where to hook up the black and red D.I.S. secondary test lead clips.

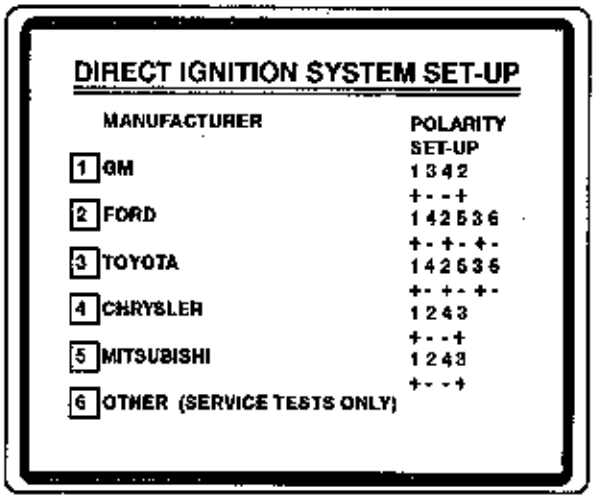

Figure 100

Connect red clips to plug wires of the cylinder numbers that have a plus (+) below them. Connect black clips to cylinders with a minus (-) below them.

Make sure the green #1 lead is connected. After the leads are connected, start the engine. Press the number that corresponds to the engine type to go to final D.I.S. set-up screen.

NOTE: As of the date of this publication, the operator may not be able to run a comprehensive test if the engine manufacturer or type is not listed here. Select "Other" and enter D.I.S. system information manually (see Figure 101); then press [ABORT] go to the Service Tests menu and run service tests.

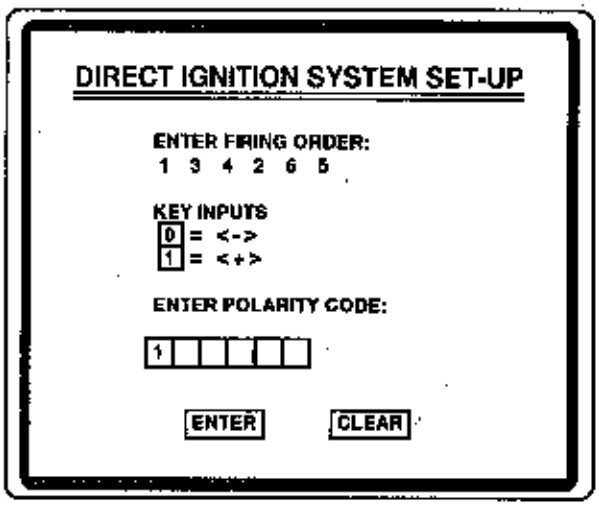

Figure 101

3. The next set-up screen shows the trigger mode. The trigger mode is automatically set to "SECONDARY" for D.I.S. testing (see Figure 102). To use a primary trigger, press [1] to change this line to "PRIMARY," and connect the D.I.S. primary lead (see Figure 103 and "D.I.S. Primary Lead" in the "Introduction" section of this manual).

The second and third lines show the number of cylinders, the firing order and polarity setup. This is the information selected when the engine type was selected on the previous screen.

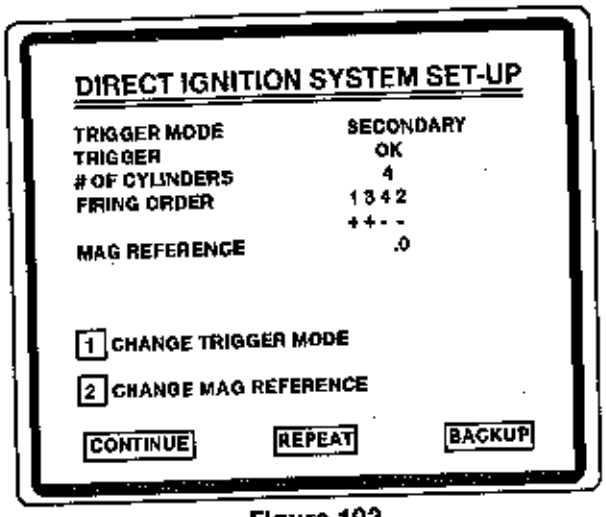

Figure 102

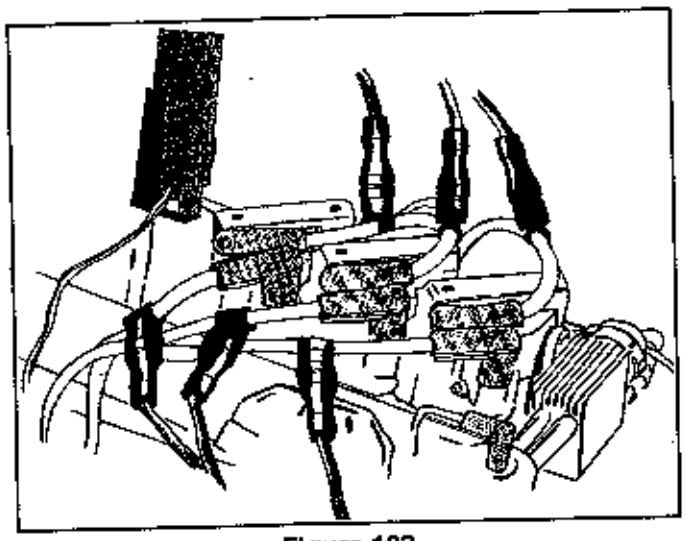

Figure 103

4. Press [CONTINUE] to continue testing. Press BACKUP to return to engine selection screen.

Comprehensive: Gas Analyzer Status

If the (optional) gas analyzer status is OK, press [CONTINUE] (see Figure 104).

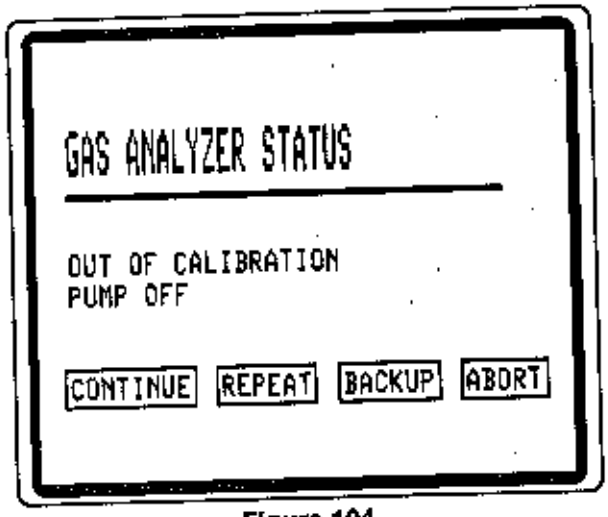

Figure 104

If the screen shows that the gas analyzer is not ready for use, either:

Wait until the gas analyzer is warmed up (this takes about 14 minutes from the time the analyzer is turned "ON"), and then press [REPEAT] to re-check gas analyzer status and continue testing.

OR

If analyzer is warmed up, press [ABORT]. Refer to the gas analyzer operating instructions to perform gas calibration.

OR

Press [CONTINUE], and disregard all gas analyzer information. No diagnostic information using the gas analyzer will be available on the "Results" report.

Comprehensive: Zero Amp Probe

This procedure allows the computer to get a zero current reading, which it uses to calculate current flow during Comprehensive Tests testing. Follow the screen prompts (see Figure 105) and:

1. Remove the grey amps probe from and all conductors and close the clamp completely.

2. Press [CONTINUE]. Clamp the probe around all conductors from the negative (-) or positive (+) battery terminal, and be sure the clamp is fully closed.

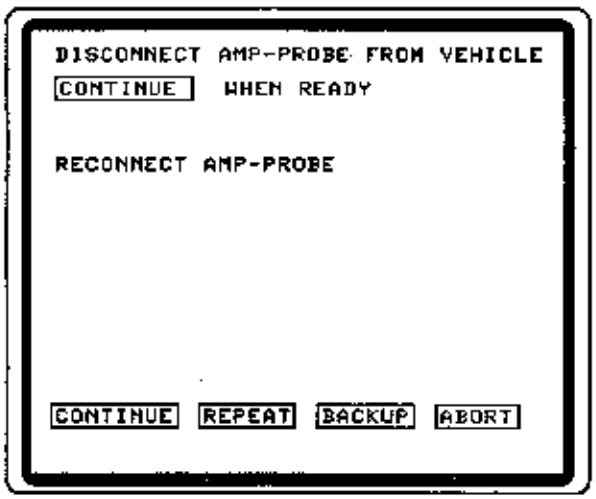

Figure 105

NOTE: The probe is non-directional; the arrow on the probe case does not apply.

Comprehensive: On-board Computer Codes - D.I.S.

If the analyzer is equipped with the "Fuel Management" on-board computer test option, the operator can access those tests here. The option appears during Comprehensive Tests only if specs have been entered for a Ford or GM D.I.S. vehicle.

Screen asks "Test Vehicle On-Board Computer?" (see Figure 106). Press:

[1] "YES," to go to the test;
[2] "NO" to skip it.

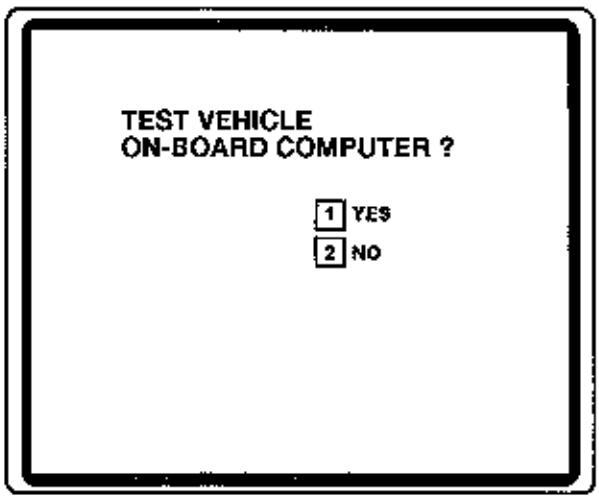

Figure 106

(If the analyzer is not equipped with this optional test, the screen prompts "TEST NOT AVAILABLE" if the operator presses [1].)

Summary of On-Board Computer Codes Test

The specification screen for GM or Ford appears. Enter engine code and any other specs, as necessary. Then press [CONTINUE].

For GM Vehicles:

The test goes right to the fault codes data stream screen. Prom I.D. and fault codes are displayed. To move to any other GM data stream screen, use right or left arrows to page through, or press numbers to directly select other data stream menu choices. (The menu will not appear on the screen, in this case.)

For FORD Vehicles:

Performs "EEC-IV Engine Off" self test. A brief explanation of procedures follows. For complete information, see "Fuel Management" instructions.

On-Board Computer Tests

1. From the "Test Vehicle On-Board Computer?" screen, press [1] for YES. The GM or Ford specifications screen appears (see Figure 107).

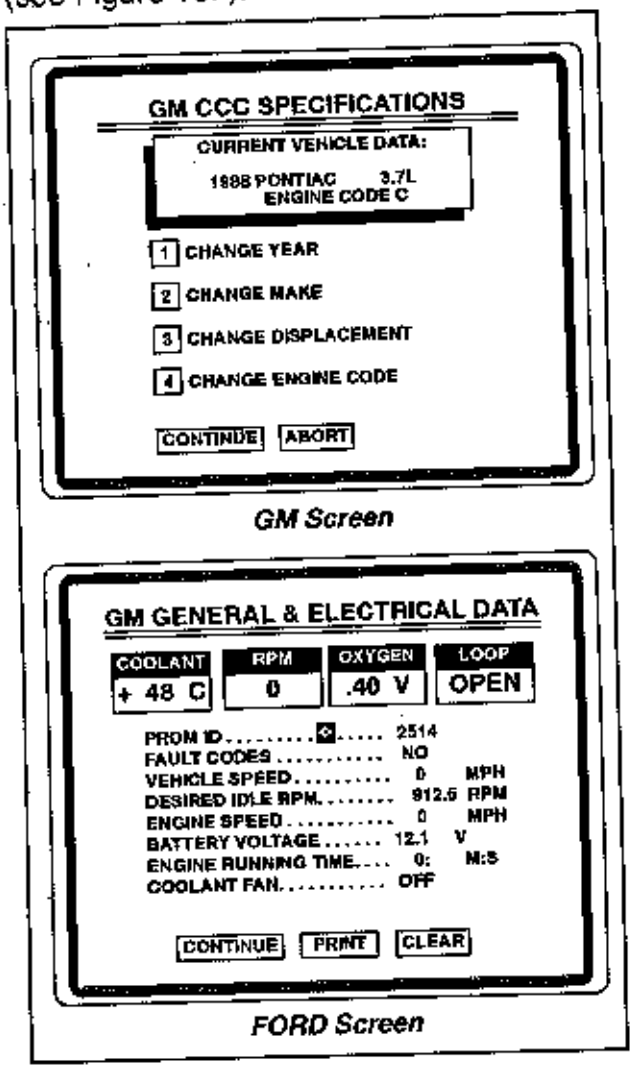

Figure 107

2. Use typewriter keypad to enter the engine code — the 8th character in the vehicle identification number. (For Ford, press [1] to enter the code; for GM press [4].)

Continued...

3. All other information on screen will be from the previously entered specs. Enter or change specs as necessary.

4. Using the proper adapter (GM or Ford), connect the A.C.E. diagnostic lead to the vehicle self-test connector (see "Fuel Management" instructions for descriptions of adapters and test leads). Turn key "ON", but do not start the engine. Press [CONTINUE].

   (If connector is not properly connected or key is not "ON" at some point during test, screen will read "CONNECT ALDL." Correct the condition and press [REPEAT], or press [CONTINUE] to continue Comprehensive testing.)

For GM Vehicles:

The first screen shows "PROM ID," then lists fault codes (see Figure 108).

Select other GM data screens by pressing Right or Left Arrow keys to page through the menu, or press number keys to select data screens.

Press [PRINT] from any data screen to record test information.

Press [CONTINUE] to continue with Comprehensive testing.

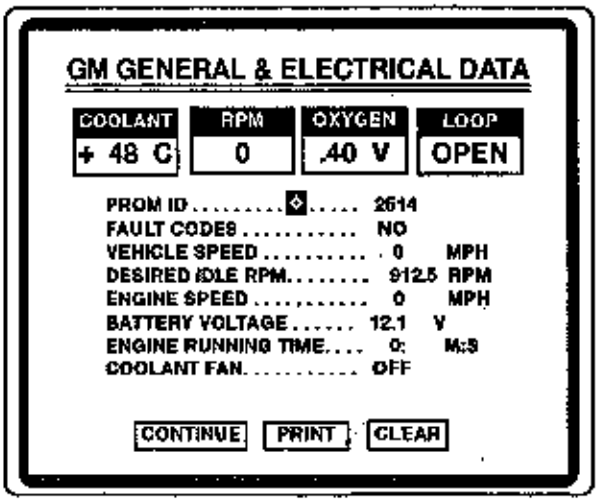

Figure 108

For Ford Vehicles:

The first screen lists instructions for preparing the vehicle (see Figure 109). Follow these instructions carefully and make sure the leads listed are connected.

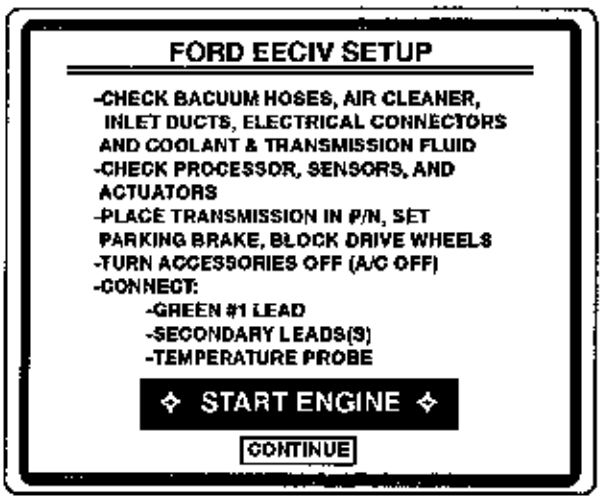

Figure 109

Ford Vehicles (continued)

Start the engine as prompted and perform a 2-minute warmup. Follow screen instructions.

NOTE: If the engine will not start, press [CONTINUE] to proceed with Comprehensive testing.

After warm-up, shut engine "OFF" and leave key "ON", as screen prompts. Make sure all self-test connectors are connected. Press [CONTINUE] to read fault codes.

After fault codes are read, press [PRINT] to record the data.

Press [CONTINUE] when the last test screen appears. The display screen reads "TEST COMPLETED" (see Figure 110).

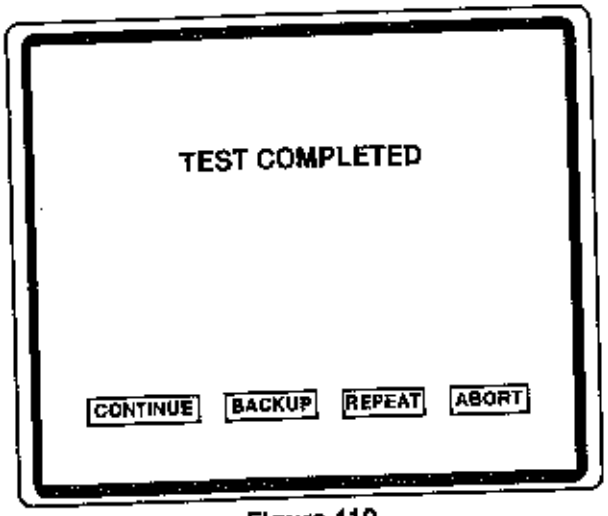

Figure 110

Press [REPEAT] to run the test again.

Press [BACKUP] to back up through the computer codes test.

Press [CONTINUE] to continue with Comprehensive testing.

Visual Check

The visual check screen allows the operator to inspect several important safety or performance related items on the vehicle before Comprehensive testing. The engine, key and electrical accessories must be "OFF" at this time.

Enter [1] or [2] to pass or fail each item in the visual check. Enter [3] to pass all visual check items. Results of this visual check will appear in "Results" report (see Figure 111).

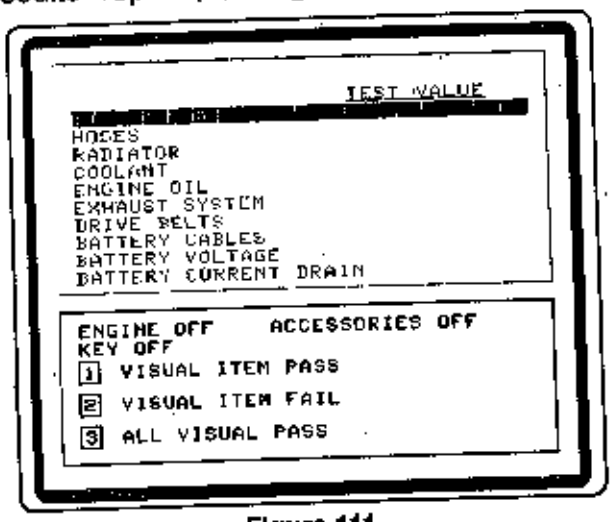

Figure 111

If the reading for battery voltage shows too low for testing, messages appear showing corrective action. The operator may continue testing however diagnostic information based on the battery test will not appear on the "Results" report (see Figure 112).

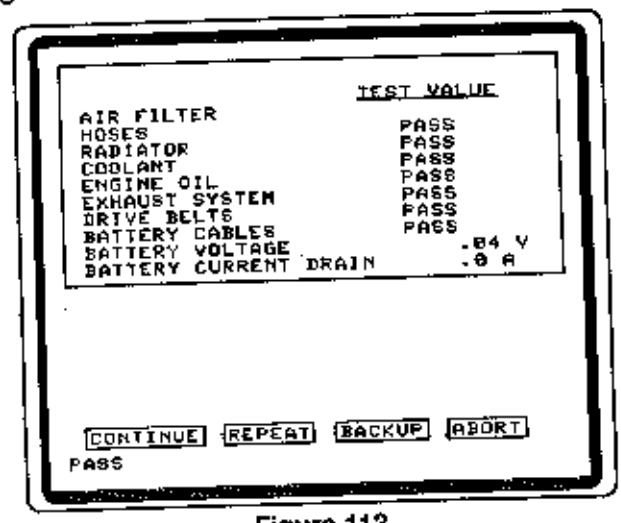

Figure 112

Battery Test

⚠ ***CAUTION:*** Observe battery safety precautions listed under "Safety" in the "Introduction" section.

For details on how the Battery Test works, refer to the "Service Tests" section.

Things to consider after testing the battery:

1. If battery marking agrees with rated C.C.A. shown on the display, press [CONTINUE] twice (see Figure 113).

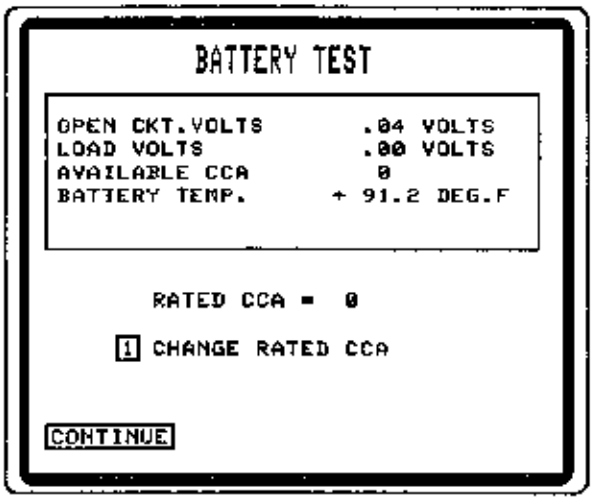

Figure 113

2. If battery marking does NOT agree with the C.C.A. rating on the display screen, press [1] and then enter the rating of the battery actually installed in the vehicle. Press [CONTINUE].

3. In some cases the analyzer will need to know if the battery has been charged. Answer YES or NO as appropriate when this screen appears (see Figure 114).

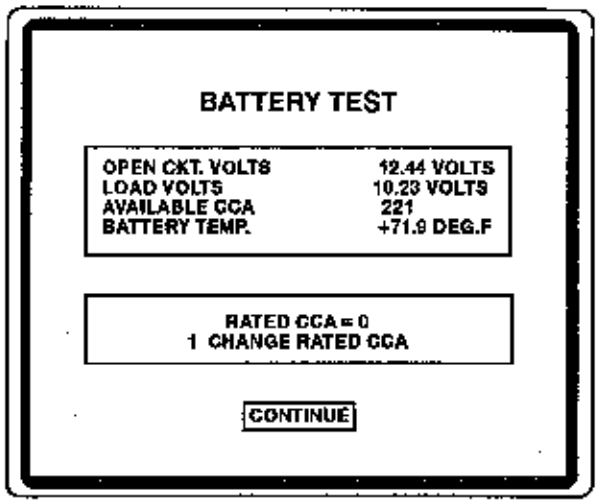

Figure 114

When voltage is too low for testing, the test displays voltage and stops battery testing.

When voltage is sufficient for testing, a series of tests are performed, information is stored for diagnostic purposes, and the screen presents the test results.

The Battery Test is complete when all four items are filled in on the display and "CONTINUE" appears at the bottom of the screen (see Figure 115).

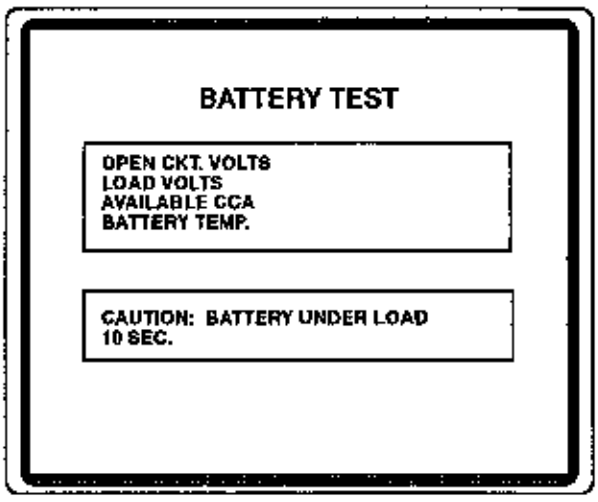

Figure 115

Cranking Test - CONV

1. Get in the vehicle driver's seat. Take the remote control pendant and a copy of the specifications, if you have them. You will have to operate the accelerator for the next several tests.

2. ***CAUTION:*** Place the transmission in "PARK" or "NEUTRAL" (manual transmissions only). Set the parking brake. Make sure the vehicle cannot roll. If necessary, chock the wheels.

3. Follow the screen prompts and crank the engine until it starts (see Figure 116). The analyzer temporarily disables the ignition primary so it can read cranking values. After a few seconds, the ignition is re-enabled.

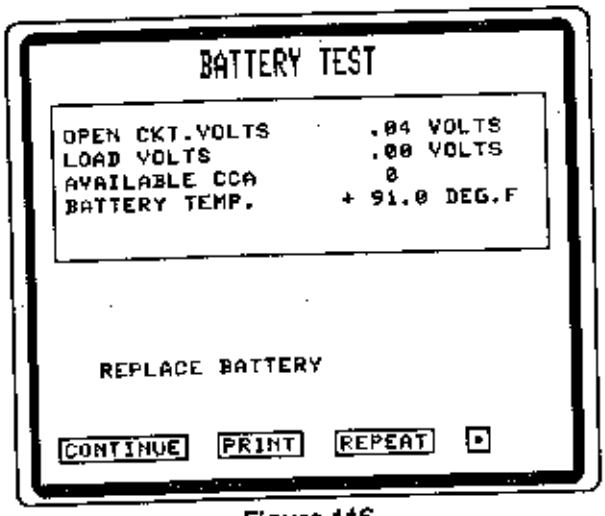

Figure 116

NOTE: The cranking test automatically checks primary, secondary, and current probe signals. If any are missing, a Cranking Test Setup screen appears, allowing the operator to correct the lead hookup, or to select a different trigger mode. See "Setup" in the "Service Tests" section for trigger mode information. Make any changes, if necessary, and press [CONTINUE] to return to the Cranking Test.

Under certain conditions, one of two messages might appear on the Cranking Test screen:

"ENGINE WILL NOT START" - This message appears if the engine does not start after ignition is re-enabled. Start the engine if at all possible. If engine cannot start, press [ABORT]. Limited, "No-Start" diagnostics will appear on results. The engine must be in running condition before a full comprehensive can be performed.

"ENGINE DIESELED" - If the engine fires the fuel/air mixture without an electric spark (dieseling) because of pre-ignition or other reasons, the rest of the Comprehensive tests can still be done. However, compression information will not be reported. Certain engines that have extremely long dwell times during cranking may trigger this message.

Cranking Test Results

The top of the screen shows Compression Percentage (see Figure 117). Each cylinder is compared with each other cylinder. The best cylinder is given the value "100." The computer then does the math which converts the value of the other cylinders to a percent of the best cylinder.

All other cranking values are also shown on screen.

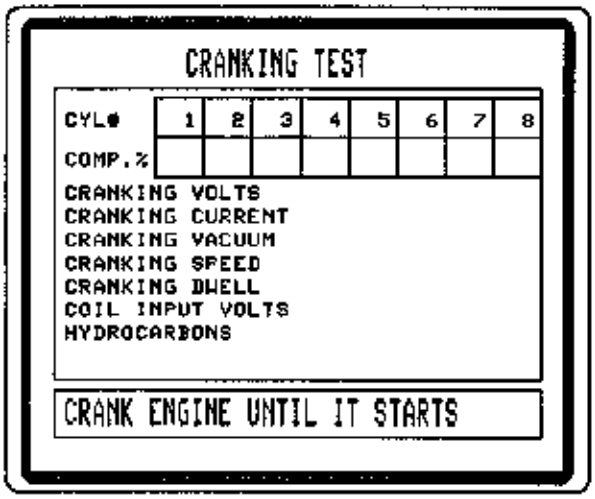

Figure 117

Cranking Test - D.I.S.

Leads Required:

- D.I.S. Secondary Leads
- Green #1 Pickup;
- White Clip;
- Secondary Yellow Lead;
- Gray Amp Probe;

For Complete Screen, Add:

- Battery Load Clamps
- Yellow Primary Clip to the Positive (+) battery terminal;
- Vacuum Lead;
- Exhaust Gas Probe
- D.I.S. Primary Lead (if Primary Trigger is selected).

1. ***CAUTION:*** Place transmission in "PARK" or "NEUTRAL" (manual transmissions only). Set parking brake. Make sure vehicle cannot roll.

2. Follow the instructions on the first cranking screen to disable ignition. The instructions shown depend on which vehicle is being tested:

3.0L Toyota and GM PFE (Ported Fuel Injection) Vehicles:

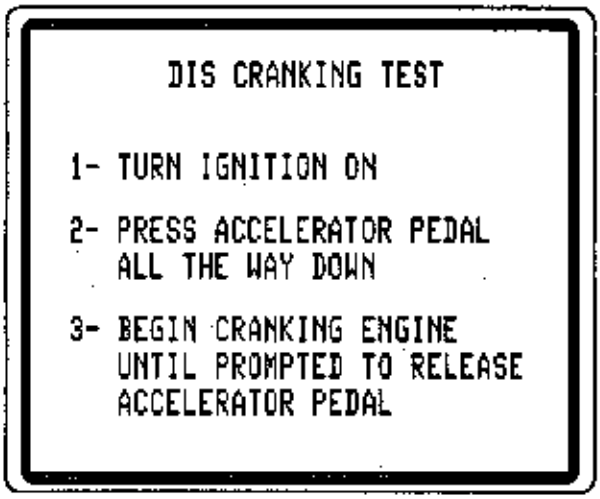

Figure 118

"1- TURN IGNITION ON"

"2- PRESS ACCELERATOR PEDAL ALL THE WAY DOWN", AFTER the ignition key is "ON." This will cause the computer on these vehicles to inhibit fuel flow because it is put in a flood mode.

"3- BEGIN CRANKING ENGINE UNTIL PROMPTED TO RELEASE ACCELERATOR PEDAL" WHILE HOLDING THE ACCELERATOR PEDAL DOWN, crank the engine until prompted to release the pedal. The analyzer takes a few seconds to read cranking values and then displays the results on the screen. When the screen prompts "RELEASE ACCELERATOR PEDAL," do so to allow engine to start.

NOTE: If the engine starts, release the accelerator pedal, turn the ignition "OFF" and repeat the test.

GM TBI (Throttle Body Injection) Vehicles (see Figure 119):

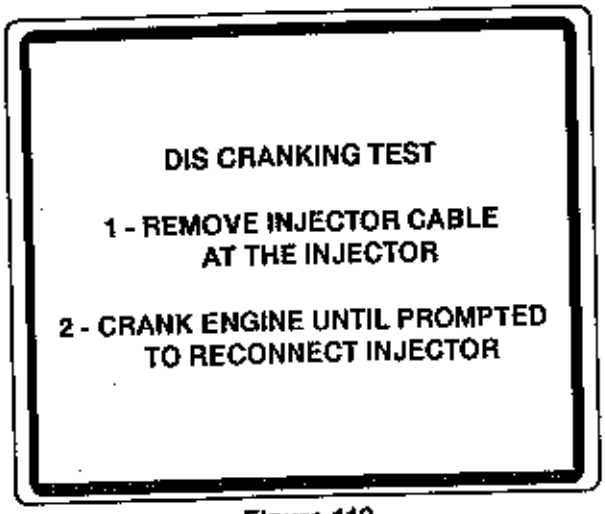

Figure 119

"1- REMOVE INJECTOR CABLE AT THE INJECTOR" - These vehicles are not automatically disabled when the throttle is wide open. Remove the injector cable to disable fuel flow. Remove the rubber or plastic airflow filter over the injector and then unplug the cable connector at the injector.

"2- CRANK ENGINE UNTIL PROMPTED TO RECONNECT INJECTOR" - When results appear on the screen, discontinue cranking. Reconnect injector and start engine, as the bottom of the screen prompts.

Ford, Chrysler/Mitsubishi, and "Other" Systems (see Figure 120):

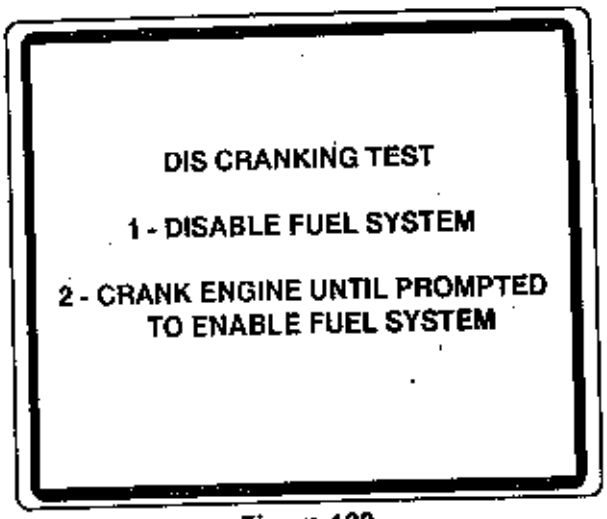

Figure 120

"1- DISABLE FUEL SYSTEM" - For instructions, press [0] to see a Help menu. From the Help menu, select the type of system being tested. The screen shows instructions for disabling that system.

NOTE: Selections 4, 5, and 6 are for Ford of Europe systems.

For examples, see Figure 53, 54 and 55 in the "Service Tests" section. After disabling system, press [0] to return to cranking screen.

"2- CRANK ENGINE UNTIL PROMPTED TO ENABLE FUEL SYSTEM" - When results appear on screen, discontinue cranking. Re-enable the fuel system, as bottom of screen prompts, and start engine.

D.I.S. Cranking Test Set-Up

During cranking test, the analyzer checks the trigger. (Remember, the trigger is secondary unless changed.) If trigger is OK, the Set-Up screen does not appear. Go on to "DIS Cranking Test Conditions."

If trigger is faulty, a "DIS Cranking Test Setup" screen appears (see Figure 121). This shows the trigger mode and indicates that the trigger is either "FAULTY," or "MISSING."

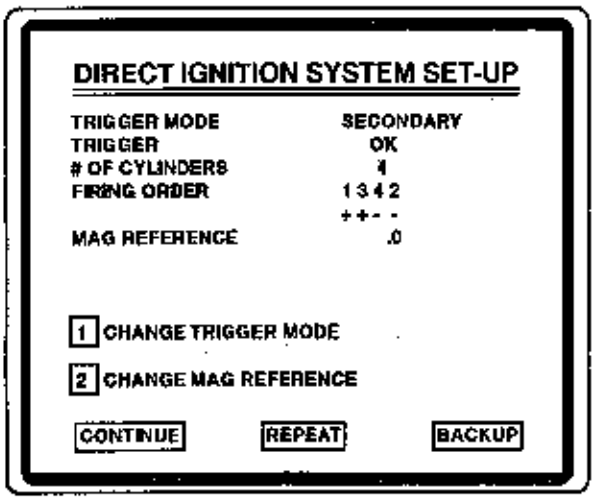

Figure 121

When trigger is "FAULTY," the signal is irregular or unsteady. When screen reads "MISSING," the analyzer is not getting a signal from the trigger (see Figure 122). In either case, check the secondary leads to make sure they are connected securely and have the correct polarity setup.

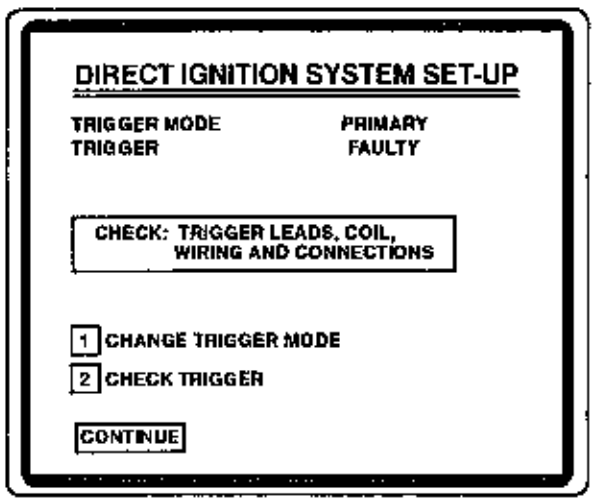

Figure 122

If secondary leads were not properly connected, correct the condition. Then START THE ENGINE and press [2] to check the trigger.

If trigger is still not OK, press [1] to change the trigger mode to primary. Connect the D.I.S. primary lead (see "D.I.S. Primary Lead" in the "Introduction" section for details). Use the primary trigger for the rest of the Comprehensive test.

Press [2] again (with engine running) to check trigger again. The screen shows that the trigger is OK. Press [CONTINUE] to return to Cranking Test.

Other D.I.S. Cranking Test Conditions

The following messages may appear during cranking test, under certain conditions:

"ENGINE DIESELED" - appears if a cylinder fires during cranking. This message may also appear when the trigger is bad (due to erratic RPM readings). Repeat the test. If this message appears again, go to Set-Up and check the trigger.

"ENGINE STARTED; REPEAT TEST" - appears if the engine started before cranking information could be gathered. Shut the engine "OFF." Press [REPEAT] and run the test again.

"TURN IGNITION OFF AND CHECK CURRENT PROBE" - appears at the beginning of test if the analyzer reads RPM but there is no signal from the current probe (see Figure 123). This message may also appear if the RPM is unsteady due to a faulty trigger. Check current probe (grey amp probe) and make sure it is fully closed around all vehicle wires coming from a battery terminal. Check all D.I.S. leads. Press [CONTINUE] to start test again.

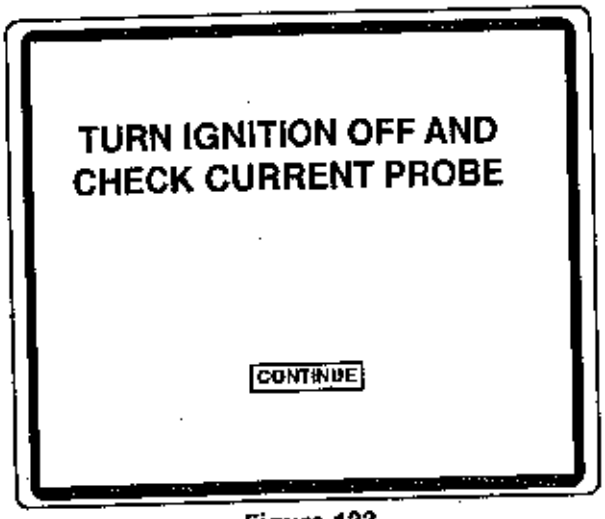

Figure 123

"ENGINE WILL NOT START; ABORT" - appears at the bottom of the cranking test results screen. If vehicle does not start after the cranking test is performed (see Figure 124). Start the engine if at all possible. If engine cannot start, press [ABORT]. Limited, "No-Start" diagnostics will appear on reports. The engine must be in running condition in order to perform a full comprehensive test.

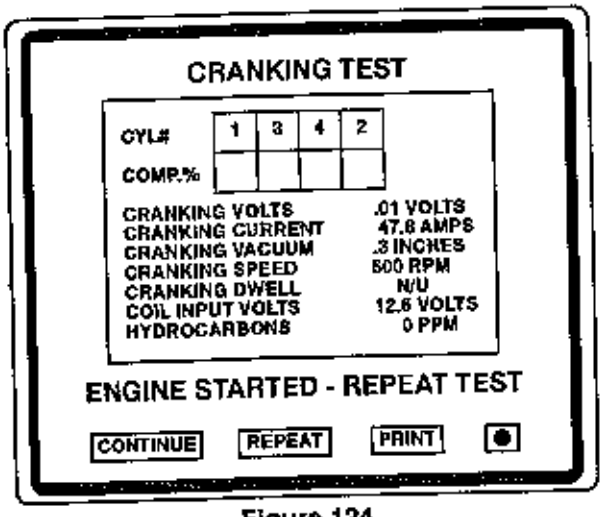

Figure 124

Adjustment Screen - CONV

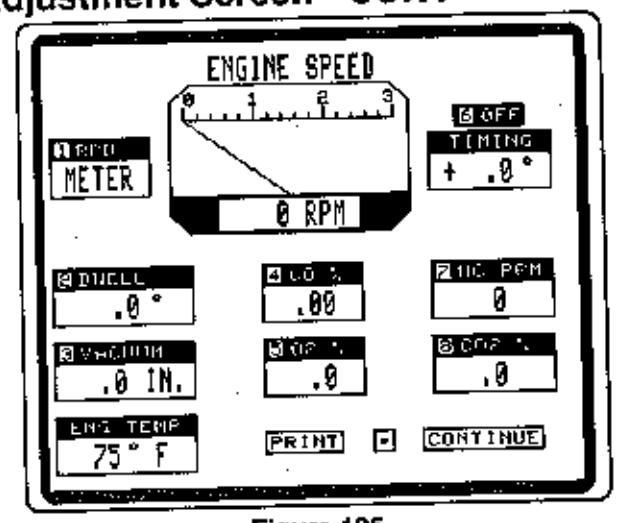

Figure 125

Now that the vehicle is running, this adjustment screen appears to allow the operator to make any needed adjustments to the engine before continuing the test.

The Adjustment screen displays:

- RPM
- Dwell
- Vacuum
- Engine Temperature
- Timing
- Exhaust gas values (if available) for:
  - Carbon Monoxide (percent)
  - Oxygen (percent)
  - Hydrocarbons (parts per million)
  - Carbon Dioxide (percent)

To display any of the above readings (except engine temperature and timing) in the center meter, press the number on the keyboard which matches the reading item number. To turn the timing light on, press [6].

Use this screen to make sure the vehicle is ready for further testing. Check for proper engine temperature, idle speed, and O_2 (oxygen) readings. (Low O_2 means the exhaust probe has been inserted correctly.)

Check the engine decal for performing idle test. If specified, place transmission in "DRIVE" after applying the parking brake.

When ready, press [CONTINUE].

Engine Warm-up - D.I.S.

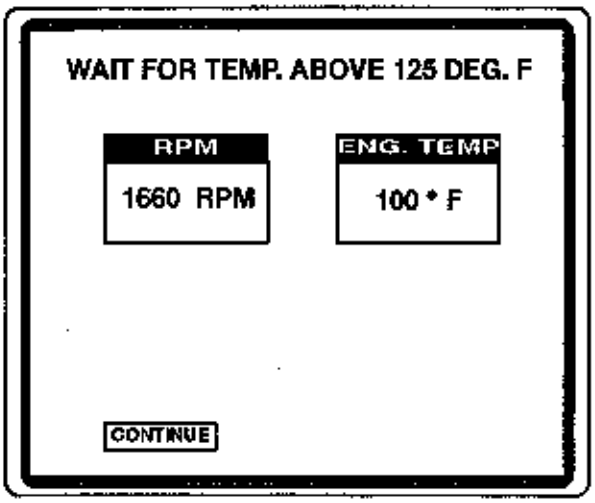

Figure 126

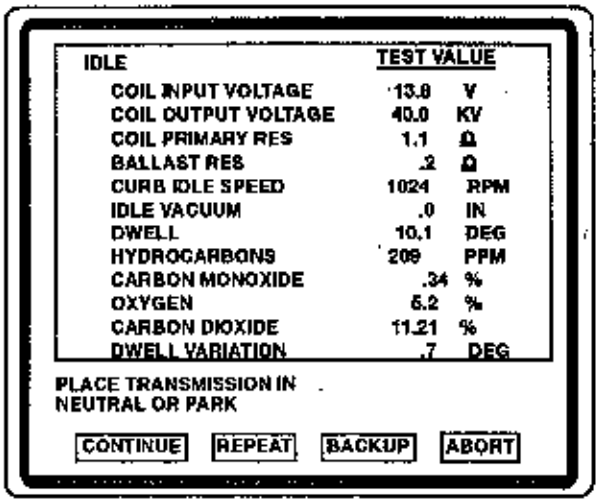

Figure 127

The screen displays engine RPM and temperature. Wait until the engine is at least 125°F to properly prepare the engine for idle report.

Use Velcro strap to attach the engine temperature probe onto the radiator hose.

DO NOT PRESS [CONTINUE] UNTIL THE ENGINE IS 125°F OR WARMER.

Idle Test Setup

Check for these conditions:

- The engine must be warm.
- Transmission must be in proper gear (according to spec).
- The choke (if equipped) must be fully open.
- The air pump (if equipped) must be working.

When conditions are met, press [CONTINUE]. The analyzer pauses occasionally to take the readings listed below, then stores the information and displays it on the screen (see Figure 127).

The Idle Report gives these values at idle:

- Coil input voltage;
- Coil output voltage;
- Coil primary resistance;
- Ballast resistance;
- Curb idle speed;
- Idle vacuum;
- Dwell;
- Hydrocarbons;
- Carbon monoxide;
- Oxygen;
- Carbon dioxide;
- Dwell variation

NOTE: Vehicles with long dwell time (notably Chryslers) will prompt the message, "REMOVE A PLUG WIRE."

Remove any plug wire and press [CONTINUE]. Then reconnect the wire as the screen prompts. This procedure allows the analyzer to get a good look at the primary ignition system of a vehicle with long dwell.

Some of the data does not apply to D.I.S. vehicles. These will say "N/U", Not Used.

PLACE THE TRANSMISSION IN PARK OR NEUTRAL (MANUAL TRANSMISSIONS). Press [CONTINUE] after all data is shown.

Secondary KV - CONV

Leads Required:

- Green #1 Pickup;
- White Clip;
- Yellow secondary lead
- Blue Primary Clip

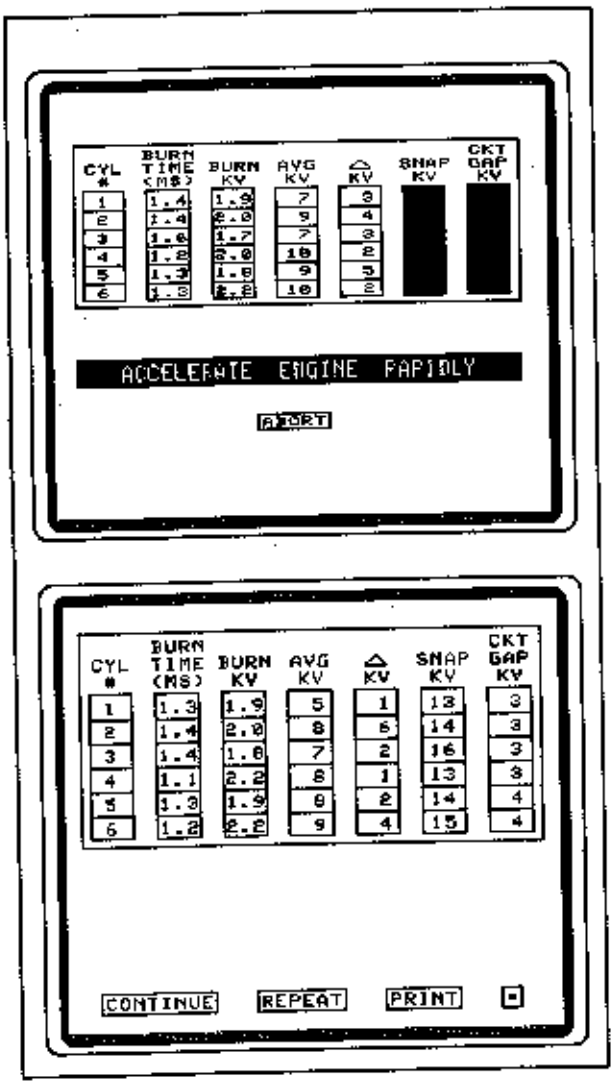

Figure 128

The KV test samples a series of firings for each cylinder, then reports on individual spark plug burn times (milliseconds) and the following KV readings:

"BURN TIME" - The length of time in milliseconds that the spark plug is arcing.

"BURN KV" - The average KV required to maintain the spark. The amount for each cylinder's secondary circuit is stored and shown on the screen in the proper cylinder column.

"AVERAGE KV" - The average KV required to initiate a spark. The amount for each cylinder's secondary circuit is stored and shown on the screen in the proper cylinder column.

"DELTA KV" - The difference between the minimum and maximum KV.

After delta KV is displayed, the operator will be prompted to snap the throttle wide open and release it. This action is needed to obtain Snap KV and Circuit Gap values.

"SNAP KV" - Secondary KV for each cylinder is sampled under load caused by engine acceleration. The highest value is stored and shown on the screen.

"CIRCUIT GAP KV" - The voltage required to jump the largest air gap (except spark plug gap) in each cylinder secondary circuit is stored and shown on the screen.

Repeating this test may yield slightly different values. This is due to variations in mixture richness, turbulence, temperature, etc.

This is a good time to leave the driver's seat. On most vehicles set the fast idle on the engine to do the next test.

Secondary KV - D.I.S.

NOTE: For any D.I.S. vehicle with all negative or all positive firings, secondary kv information will be displayed in conventional format (see "Secondary KV - CONV).

Leads Required:

- D.I.S. Secondary Leads
- Green #1 Pickup;
- White Clip;
- D.I.S. Primary Pickup (when Primary Trigger is selected)

The screen displays tachometer and digital RPM readout (see Figure 129). Allow engine RPM to stabilize at idle (800 - 1000 RPM), as the screen prompts. When RPM is stable, press [CONTINUE].

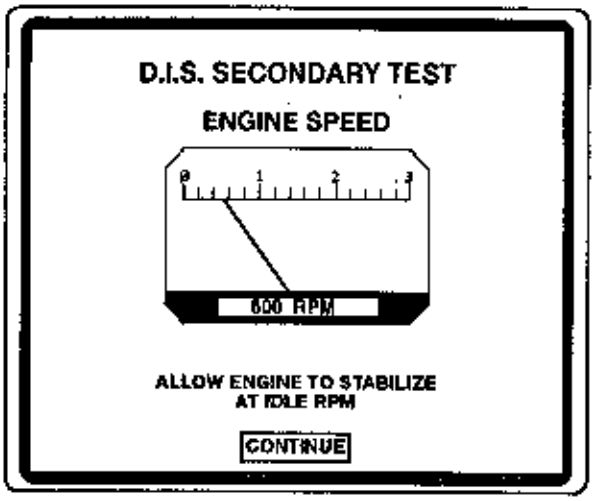

Figure 129

Secondary data is collected from the D.I.S. system (see Figure 130). The display screen highlights which data is being collected, as it is collected.

After a few seconds, the display screen reports the following KV readings for the Compression Firings and Exhaust Firings of each cylinder (see Figure 131):

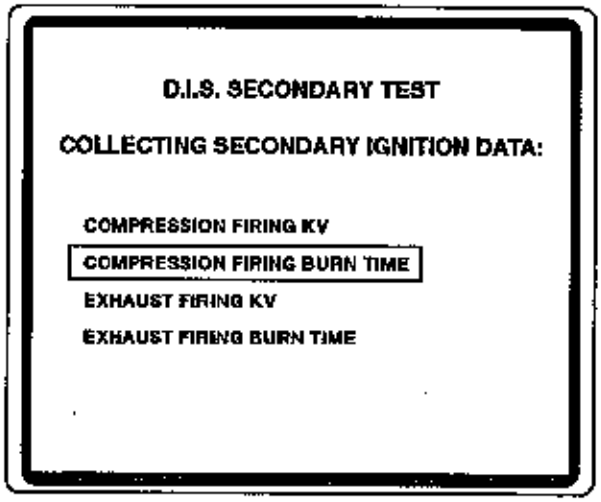

Figure 130

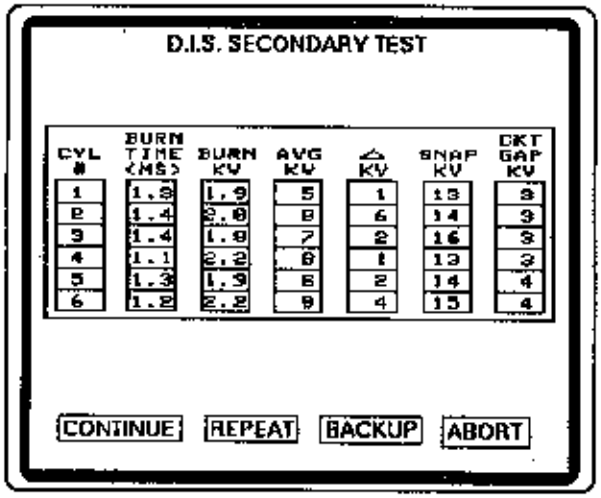

Figure 131

"AVERAGE KV" - The average KV required to initiate a spark, averaged over a number of firings.

"DELTA KV" - The difference between the minimum and maximum KV.

"BURN TIME" - The length of time in milliseconds that the spark plug is arcing.

Repeating this test may yield slightly different values. This is due to variations in mixture richness, turbulence, temperature, etc.

Fast Idle Test

NOTE: The Fast Idle Test will not be performed on vehicles whose fast idle speed is either not specified or is the same as curb idle speed. To perform the Fast Idle Test on such vehicles, edit the specifications to show a fast idle speed (must be greater than curb idle speed).

It is important to follow the prompt for the fast idle cam screw setting on the lower part of the screen (see Figure 132).

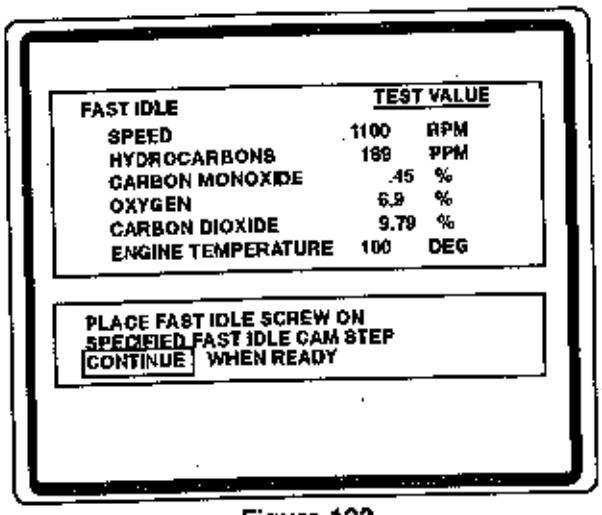

Figure 132

When the RPM becomes fairly steady, press [CONTINUE]. The "ONE MOMENT PLEASE" message appears during exhaust gas sampling, then the test resumes.

Upon completion of the Fast Idle Test, bring the engine back to normal idle in order to prepare for Cylinder Performance. Then press [CONTINUE].

Cylinder Performance - CONV

These tests check the performance of individual cylinders.

Leads Required:

- Green #1 Pickup;
- White Clip;
- Secondary Yellow Lead (standard trigger);
- Blue Primary Clip

Run the engine at idle (800 - 1000 RPM). Do not exceed 1000 RPM. When RPM is stable, press [CONTINUE].

The screen displays "CYLINDER PERFORMANCE TEST IN PROGRESS." Each cylinder number is highlighted as that cylinder is tested.

When test is complete, the results are displayed in the form of a bar graph (see Figure 133):

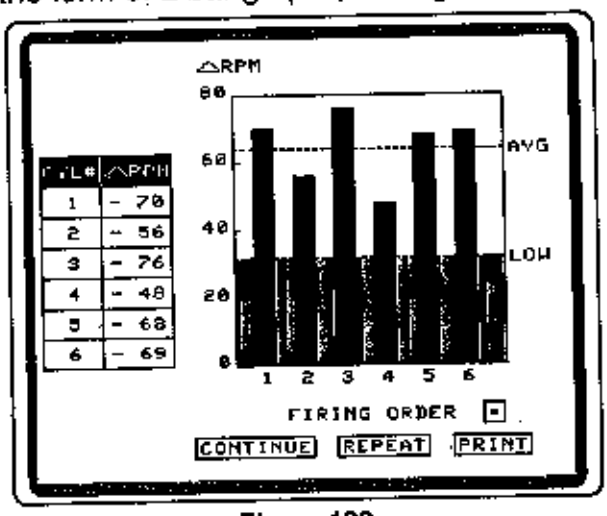

Figure 133

- The vertical bars represent the power LOST when a cylinder is "killed." The taller the bar, the greater the power loss. The bars for each cylinder are arranged in firing order.
- The "AVG" line shows the average power loss experienced during the cylinder test.
- The "LOW" line is a caution line. A vertical bar which ends below or near this line represents a weak cylinder.

Cylinder Performance - D.I.S.

Leads Required:

- D.I.S. Secondary Leads
- Green #1 Pickup;
- White Clip;
- D.I.S. Primary (if Primary Trigger is selected).

Allow engine to stabilize at idle RPM (800 - 1000 RPM), as screen prompts (see Figure 134). Do not exceed 1000 RPM. When RPM is stable, press [CONTINUE].

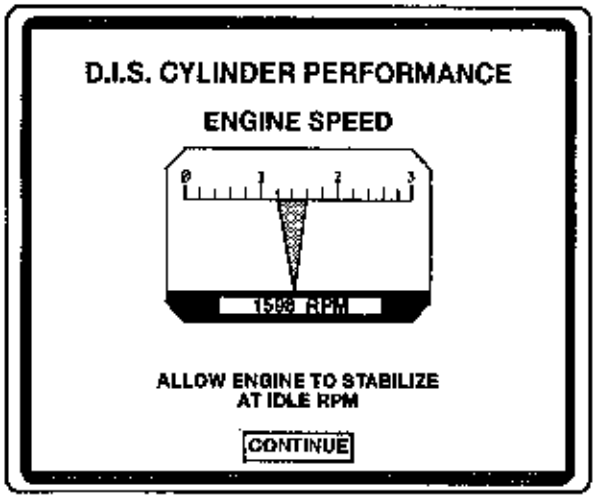

Figure 134

For GM QUAD-4 vehicles, screen prompts "STABILIZE THE ENGINE BETWEEN 1200 and 1600" (see Figure 135). A shaded background shows the range. Use a throttle adjusting tool to hold the RPM. DO NOT ATTEMPT TO HOLD IT BY HAND. RPM must be completely stable. When RPM is completely stabilized within range, press [CONTINUE].

Return QUAD-4 vehicle to idle when screen says "RETURN TO IDLE."

While test is running, the screen message says, "One Moment Please" followed by the message,"Calculating Cylinder Performance."

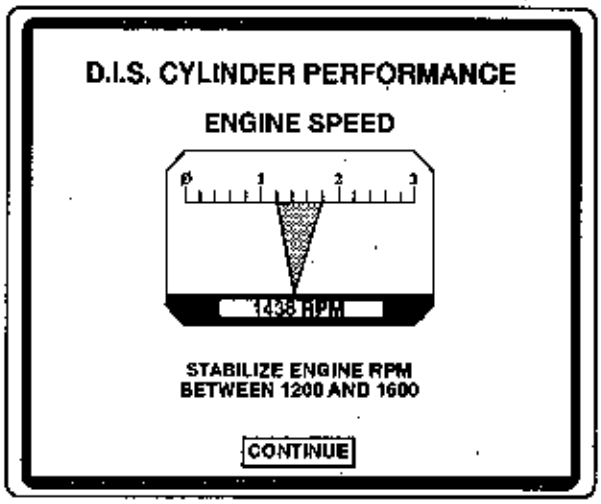

Figure 135

Wen test is complete, the results are displayed in the form of a bar graph (see Figure 136):

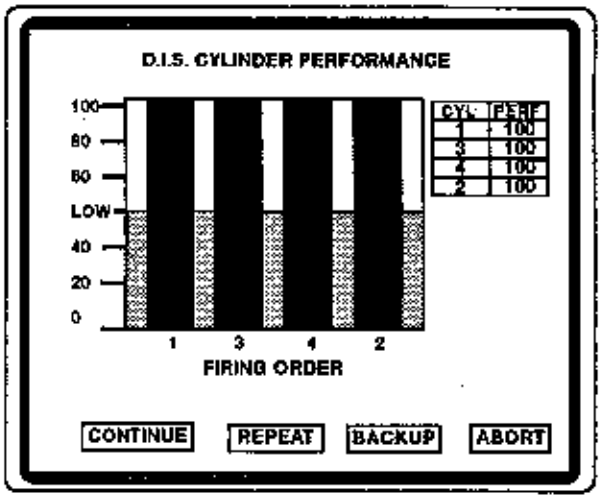

Figure 136

- There is a bar for each cylinder, arranged in firing order.
- The vertical bars represent the power of a cylinder. The smaller the bar, the lower the contribution of that cylinder.
- The "LOW" line is a caution line, set at 50 on the performance scale. A vertical bar which ends below or near this line represents a weak cylinder.

High Speed Report

Bring engine RPM over 2000 and hold it, as the screen prompts (see Figure 137). This high RPM is necessary for the High Speed Report, and for the alternator Diode Check.

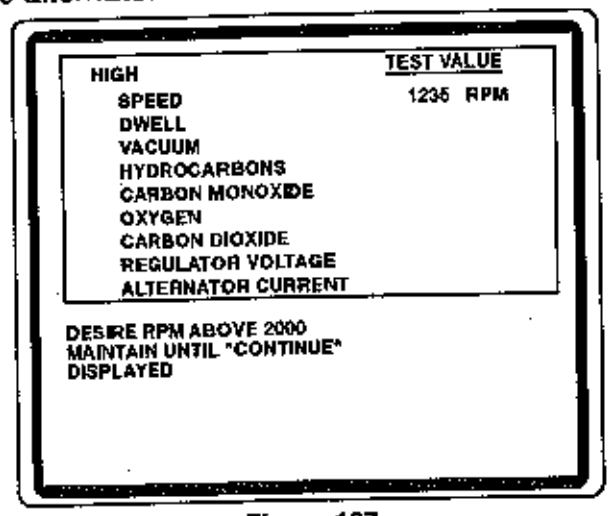

Figure 137

Screen flashes "CAUTION - LOAD" and displays a countdown for five seconds while applying an electrical load to the charging system. This is for the alternator Diode Check.

The analyzer then stores the High Speed Report values and displays them on the screen (see Figure 138). Hold 2000 RPM or higher until all the items on the screen are filled and "CONTINUE is displayed.

Release RPM and press [CONTINUE].

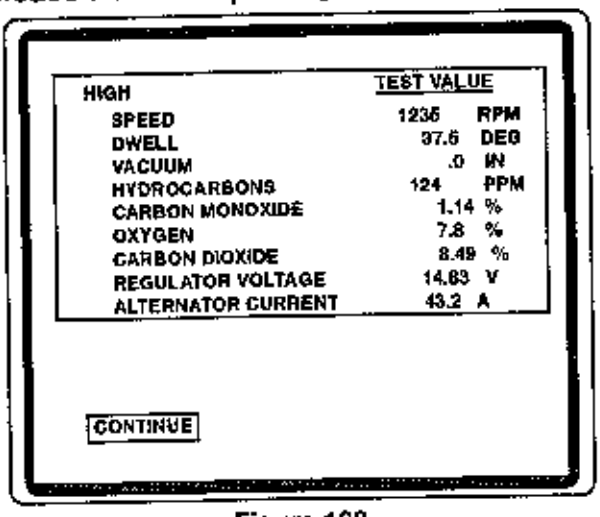

Figure 138

Diode Check

The Diode Check screen shows the alternator diode pattern. The operator must decide if it is good or bad.

Compare the pattern on the screen (see Figure 139) to the patterns on this page.

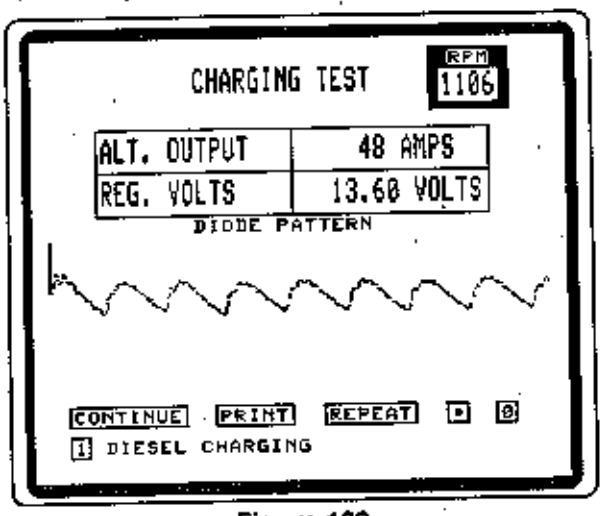

Figure 139

Good patterns have waves with generally even lengths and about the same amplitudes. Small variations are OK.

Bad patterns have widely varying wave lengths and shapes (see Figure 140).

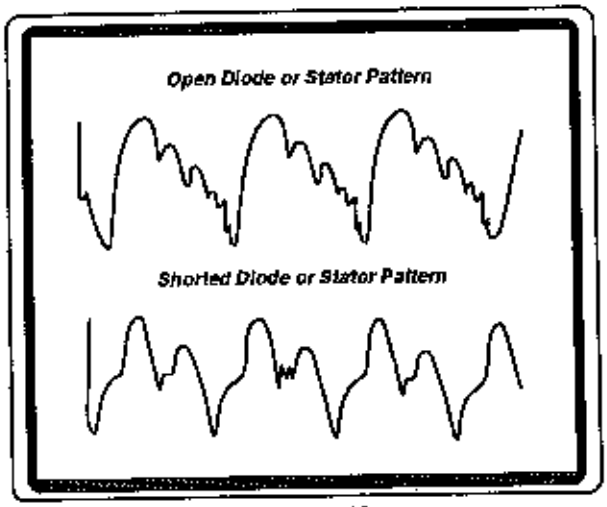

Figure 140

Timing Tests

NOTE: These procedures simply record timing values for comprehensive report. To adjust timing, use the timing feature under "Service Tests."

If specifications indicate the vehicle does not have adjustable timing, the timing tests will be skipped.

Similarly, total advance timing specifications were not entered, the Total Advance Timing test is skipped. If no mechanical advance timing spec was entered, the Mechanical Advance Timing test is skipped. (To force these tests to run, manually enter a spec through the Edit Specs screen at the beginning of Comprehensive Tests.)

There are two methods for reading timing:

1) Use a timing light;
2) Use the magnetic timing probe (on vehicles with probe sockets). If a magnetic timing signal from the vehicle is present, the timing light on the screen changes to a mag probe illustration. The analyzer then uses the magnetic timing signal for all the following timing tests.

During timing tests, watch the RPM meter. The indicator must be in the shaded area when performing timing tests.

Total Advance Timing

USING THE TIMING LIGHT: Accelerate engine steadily to about 2000 RPM. Press [ADVANCE] or [RETARD], as needed, to bring timing pointer to the zero degree mark. The strobe light is offset according to vehicle specs, so when the pointer is at the zero mark, vehicle's actual timing is on screen (see Figure 141). When mark is reached, press [STORE] on the timing light.

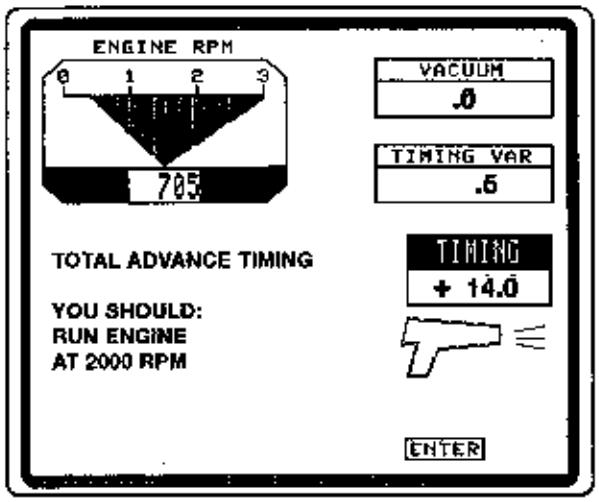

Figure 141

NOTE: Tap [ADVANCE] or [RETARD] button to move in one-half degree steps. Hold button down to move in three degree steps.

USING MAG TIMING PROBE: Accelerate engine steadily to about 2000 RPM. When speed stabilizes, press [ENTER].

NOTE: Some types of vacuum advance systems require supplementary vacuum from the analyzer for total advance testing. See manufacturer's recommendations for vacuum information. Use the analyzer's vacuum pump feature to supplement vacuum. Connect the vacuum pump to the vacuum meter with a T-fitting.

Timing Variation

Timing variation shows the difference in ignition timing between the earliest and latest firing cylinders. (Vehicles with uneven cylinder firing, for example, some GM V-6's, show wide variation because of engine design.)

Mechanical Advance Timing

USING THE TIMING LIGHT: Accelerate engine steadily to about 2000 RPM, with vacuum disconnected from distributor.

Press the [ADVANCE] or [RETARD], as needed, to bring timing pointer to the zero degree mark. The strobe light is offset according to vehicle specs, so when pointer is at the zero mark, vehicle's actual timing is on screen (see Figure 142). When mark is reached, press [STORE] on the timing light.

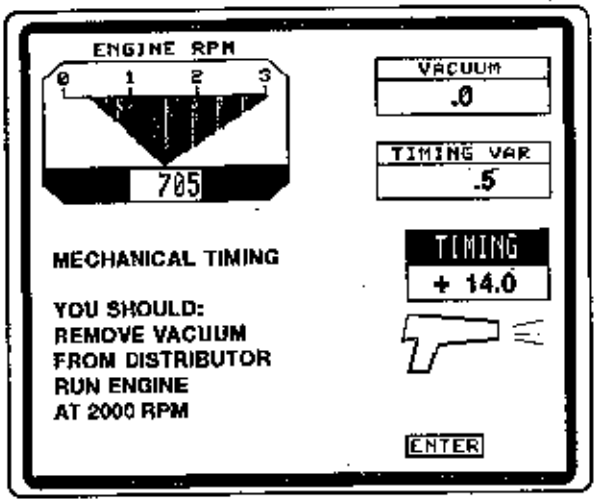

Figure 142

NOTE: The pointer might line up with zero right away, if the vehicle engine timing agrees with the spec.

USING MAG TIMING PROBE: Accelerate engine steadily to about 2000 RPM with vacuum disconnected from distributor. When speed stabilizes, press [ENTER].

Basic Timing

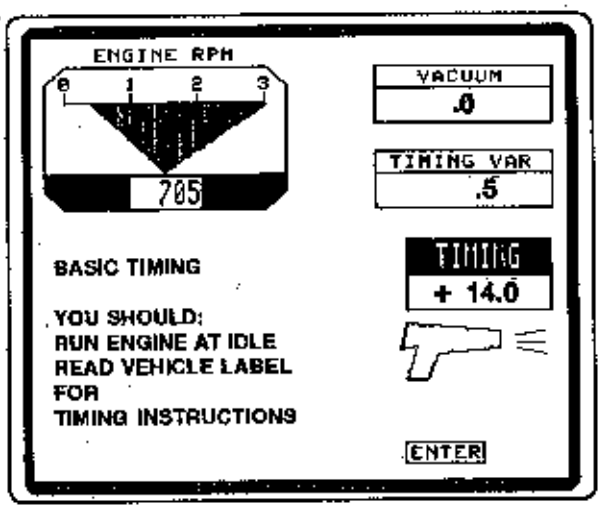

Figure 143

USING TIMING LIGHT: Follow vehicle label instructions for basic timing. Press [ADVANCE] or [RETARD] (as needed) to bring timing pointer to zero degree mark. When mark is reached, press [STORE] on the timing light.

NOTE: The pointer might line up with zero right away, if the vehicle engine timing agrees with the specification.

USING MAG TIMING PROBE: Follow vehicle label instructions for basic timing. When engine speed stabilizes, press [ENTER].

Timing Summary

The testing portion of the Comprehensive Tests test series is complete. The results of the timing tests are stored in memory and displayed on the screen (see Figure 144). Press [CONTINUE] to return to the Automatic Testing menu screen.

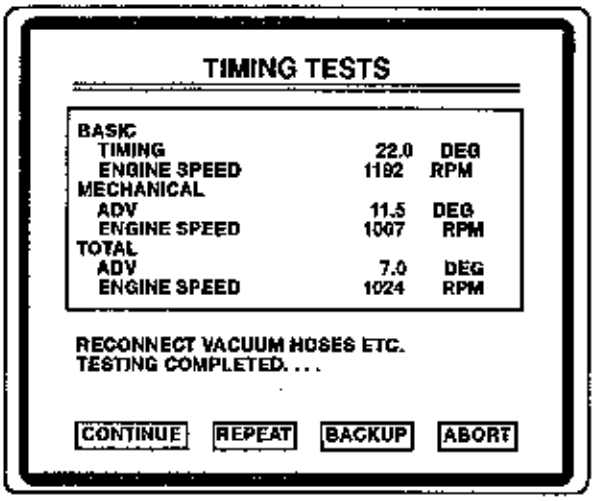

Figure 144

NOTE: Press [REPEAT] to return to the Total Advance Timing screen.

The mechanical and total advance values on this screen do not include basic timing.

Summary

The operator regains control of the unit when the menu screen appears (see Figure 145). Select "RESULTS" to review the test results on the screen, or to obtain a copy from the optional paper printer for the customer or other reference.

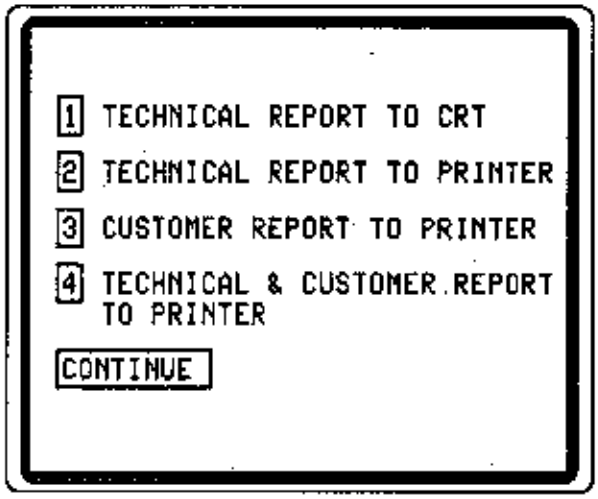

Figure 145

Create Custom Tests

"Create Custom Tests" allows the operator to assemble customized test sequences. These sequences are then stored in memory and can be selected at any time from the "Run Custom Tests" menu selection.

For example, the operator could set up a Custom Test for a seasonal promotion (this might include Customer Information, and Battery, Starting, and Charging tests, etc.). Any time a car comes in for that promotion, simply run the custom test. This makes the analyzer flexible, while still quick and automatic.

Custom tests are easy to create and run.

Plan Custom Tests

When creating a custom test, plan it before pushing buttons. Decide which tests to include and in which order. Here are a few tips:

- "Setup" should be included at start of all custom tests.
- Put tests in an order that makes for an easy, natural test flow. Avoid having to restart the test vehicle several times during the test. For example, put battery test (an engine-"OFF" test) before starting test (engine cranking) before ignition test (engine running).

Summary Instructions for Custom Tests

1. Select "Create Custom Tests" from Automatic Testing menu. If no custom tests exist yet, the screen reads "CREATE CUSTOM TESTS (Y/N) ?" (see Figure 146). If one or more custom tests do exist, bottom line of screen offers three selections:

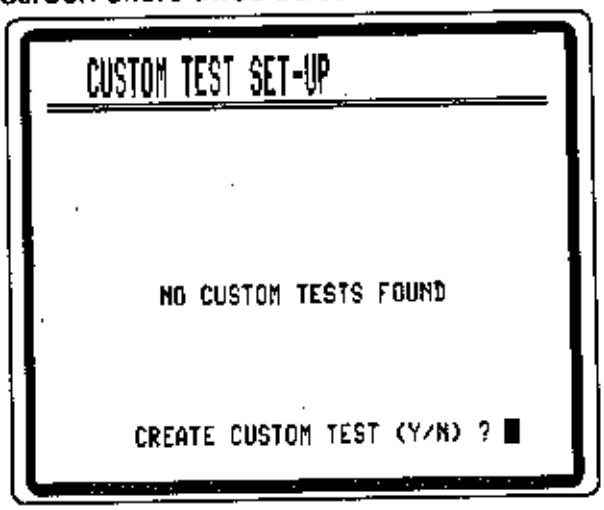

Figure 146

"1. CREATE" - Create new custom test or edit existing tests.
"2. DELETE" - Remove custom test from memory.
"3. PRINT" - Print one or more custom tests.

2. Press [Y] or make a selection. Follow the screen prompts which appear at the bottom of the screen. For details, see the step-by-step instructions.

3. After a custom test is created, it appears on the "Run Custom Tests" menu (under Automatic Testing), under its assigned title. To run a custom test, simply select it from that menu.

Create Custom Test

1. From the Custom Test Set-Up screen (see Figure 147), press:
   [Y] if no custom tests exist yet;
   [1] to create a new test;
   [2] to delete a custom test from memory;
   [3] to print one or more custom tests;
   [ABORT] to return to Automatic Testing menu

2. If the operator presses [1], the bottom line of the screen will change to read "CREATE NEW (N) EDIT (TEST NO.)." To create a new custom test, press [N]. To edit an existing custom test, press the correct test number and see "Edit Custom Test" instructions on the following page.

3. The next screen asks "DO YOU REQUIRE A PRINTOUT OF SYSTEM TEST NUMBERS? (Y/N)" (see Figure 148). The analyzer will print a list of all of the system tests with their I.D. numbers. These I.D. numbers must be entered to create the custom test sequence. Press [Y] to print; [N] to go on.

4. Enter the name for the new custom test, as prompted (see Figure 149). Press [ENTER] when finished.

5. The screen shows the custom test name at top and reads "ENTER SYSTEM TEST NUMBER." On the system number printout, find the individual test I.D. numbers for the tests to be included in the custom sequence. Enter the system test numbers, in the order planned. Test names appear on screen as they are entered, along with their I.D. numbers.

6. After the last test sequence is entered, press [ENTER] again to exit the "Create" mode. The message "EDIT THIS TEST?" appears at the bottom of the screen. Take a good look at the sequence on screen and make sure it is correct. To edit, press [Y] and see "Edit Custom Test," below. To return to first custom test screen, press [N].

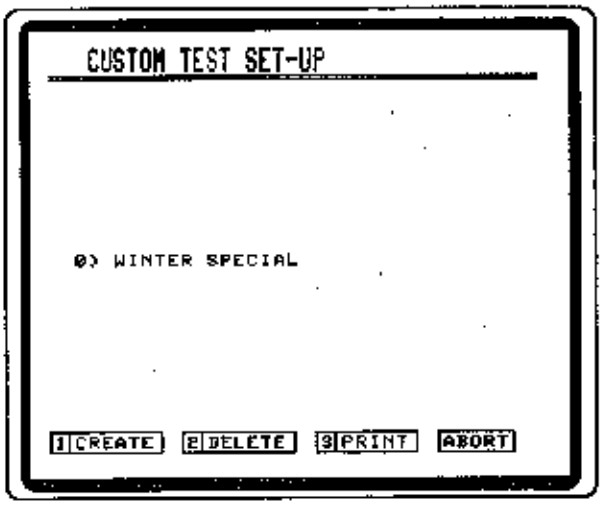

Figure 147

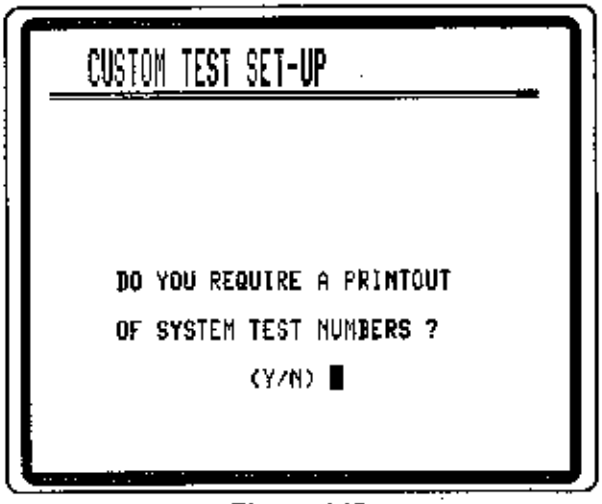

Figure 148

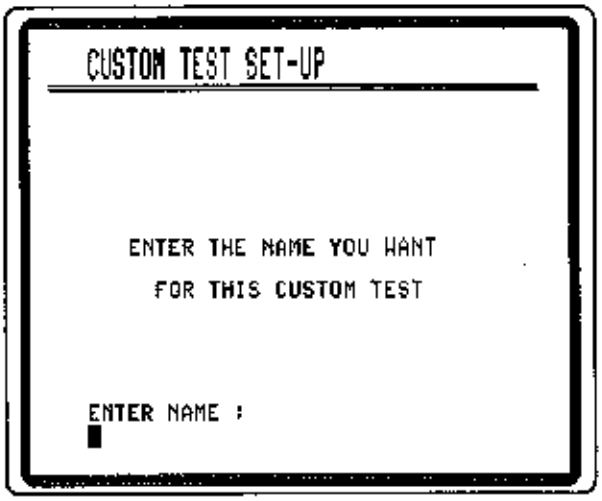

Figure 149

Edit Custom Tests

1. Starting from first custom test screen, press [1] "CREATE." The screen lists the custom tests that already exist, along with their test numbers. The bottom of screen reads "CREATE NEW (N) EDIT (TEST NO.) ?." Enter the number of the custom test that must be edited.

2. The message "ADD OR DELETE?" appears. (If starting from within a "create" routine, begin editing here.) Press [A] to add a test; [D] to delete.

3. If adding a new test, enter the number where a new test should be inserted (see Figure 150). If deleting, enter the test number to be deleted.

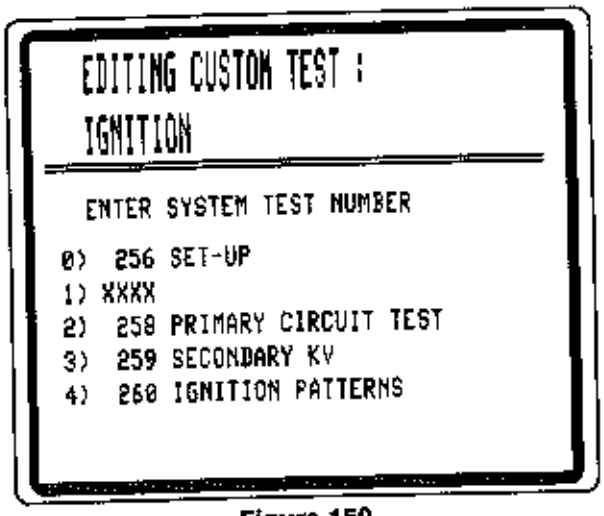

Figure 150

4. The message "EDIT THIS TEST ?" appears (see Figure 151). This gives the operator a chance to make another change. To make another change, press [Y] and go through the cycle again. If not, press [N] to return to first Custom Test Set-Up screen.

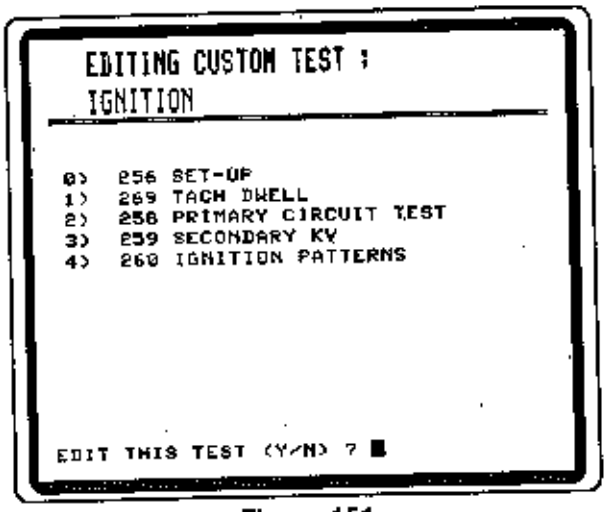

Figure 151

Delete Custom Test

Press [2] from the first Custom Test screen. The message "ENTER TEST NO. OR "A" FOR ALL TESTS" will appear.

Press the number of the test to be deleted. The analyzer will remove that test from memory. Press [A] to remove all custom tests from memory.

Print Custom Test

Press [3] from first Custom Test screen. The message "ENTER TEST NO. OR "A" FOR ALL TESTS" appears. Press the number of test to be printed or press [A] to print out all custom tests.

Run Custom Tests

Select Automatic Testing from the Master Menu. Then select "Run Custom Tests." The tests created by the operator will be listed and numbered on screen, starting with 0. Press the number of the test to run.

If No Custom Tests Exist Yet

If the operator selects "Run Custom Tests" when no custom tests exist yet, the program offers the chance to create one. Follow the screen messages to create a test (see "Custom Test Setup" instructions for details). After creating a test, the program will return to the "Run Custom Tests" menu.

Command Bar Appears During Custom Tests

While running a custom test, the command bar appears between individual system tests (see Figure 152):

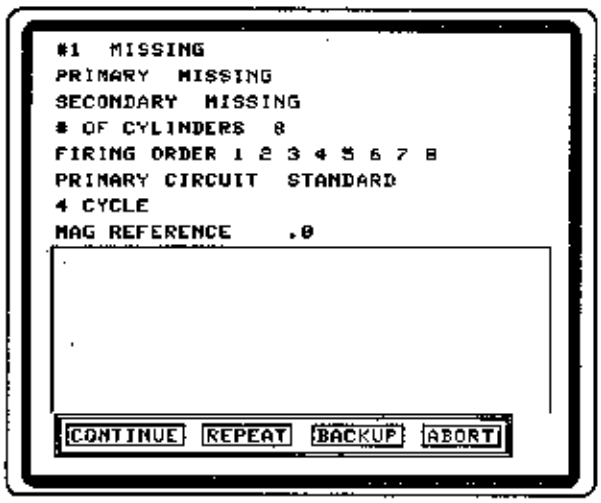

Figure 152

"CONTINUE" - Continue with the next step in the sequence.

"REPEAT" - Repeat the last test or procedure performed.

"BACKUP" - Back up to a preceding test or step.

"ABORT" - Discontinue testing and return to the Custom Tests menu.

This gives control over the flow of the custom test after it has been entered.

Dealer Identification

This screen shows the dealer information available when Dealer ID is selected (see Figure 153). If the information is appropriate, it can be printed on the paper printer by pressing [1] on the numeric (red) keypad.

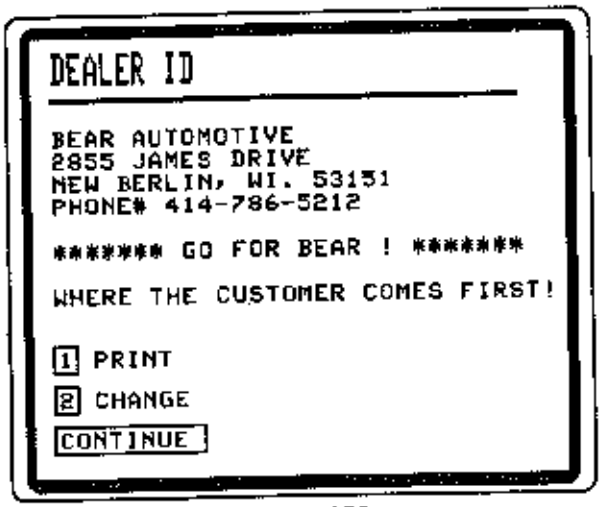

Figure 153

To change the information, (update the message, for example), press [2] on the numeric (red) keypad.

NOTE: Before inserting new information on a line, press [CLEAR]. This will ensure that any previous information is deleted. After entering new information, be sure to CLEAR any unwanted information from the remaining lines.

Prompting messages help arrange information in a convenient form (see Figure 154); however, any message placed on any line (any combination of 34 numbers or letters) can be printed.

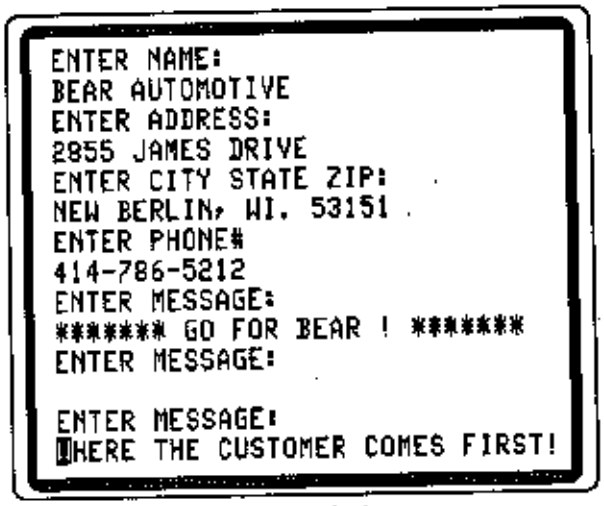

Figure 154

To print, press [1].

Information entered on the Dealer ID screen is stored in the long term (battery supported) memory, and is saved during power "OFF" and "RESET" conditions.

Customer Information

This screen shows the customer information available when the screen is selected (see Figure 155). If the information is appropriate, press [1] on the number (red) keypad to print the information on the optional printer.

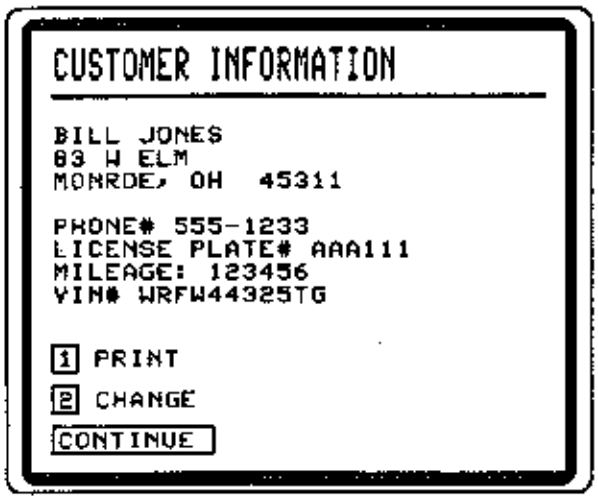

Figure 155

To enter or change information, for a different customer for example, press [2] on the numeric keypad.

NOTE: Before inserting new information on a line, press [CLEAR]. This will ensure that any previous information is deleted. After entering new information, be sure to CLEAR any unwanted information from the remaining lines.

Prompting messages helps arrange information in a convenient form (see Figure 156).

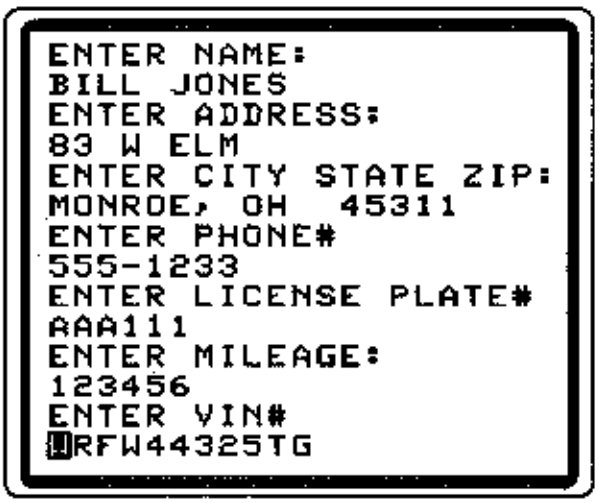

Figure 156

To print, press [1].

NOTE: The current date and time will automatically appear on each printout.

Information entered on the customer screen is NOT stored in the long term (battery supported) memory, and is lost during power "OFF" and "RESET" conditions.

Specifications

Specifications are held in memory until replaced by another set of specs or until power is shut "OFF" or the "RESET" button is pressed.

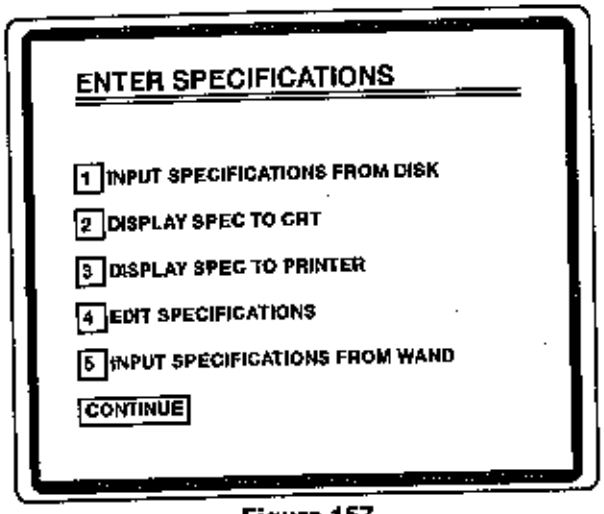

Figure 157

Input Specifications From Disk

To input specs from the disk, select the vehicle year, make, model, and then such information as transmission type, engine size, and i.d. number. Based on operator selections, the computer reads a set of specs into memory, and displays them on the screen.

1. Press [1]. The top of the screen prompts a series of steps, beginning with "SELECT YEAR"; then "SELECT MAKE," etc. At each step, move the cursor (reverse video bar) to the correct selection and press [ENTER].

There are two ways to move the cursor here:

- For numeric information (such as Year), use the arrow keys. Up and Down arrows move cursor up and down the columns. Right and Left arrows move cursor between columns.

- For alphabetical information (such as Make or Model), press the first letter of the desired selection. The cursor automatically moves to the first item beginning with that letter. From there, press that same letter repeatedly to move through selections beginning with that letter, or press the down arrow key.

2. Select each item as the screen prompts. For most vehicles, the operator will be required to enter: Year, Make, Transmission Type, Engine Size, Emissions Region, and Identification Number.

   This information is usually printed on an emissions decal somewhere in the engine compartment (often on the inside of the hood, or on the fan shroud).

3. After the necessary information is entered, the screen shows the selection.

   If the information is not correct, press [BACKUP] to go back and re-enter. Or press [REPEAT] to start over.

   If information is correct, press [ENTER]. The screen reads "READING DISK," then "SPECS FOUND." Specs are read into memory and first specs page is shown on the screen. Press [CONTINUE] to page through all the specs.

Continued...

Specifications (continued)

Display Spec to CRT / Display Spec to Printer

Press [2] to show the specs currently in memory on the display screen. Press [CONTINUE] to page through specs.

Press [3] from Specs menu to print specs currently in memory.

Edit Specifications or Input Operator Specifications

1. Press [4]. Screen shows specs currently in memory, and the cursor (reverse video bar) appears on specs in first line.

2. Use arrow keys to move cursor to the correct line. Then type in the new value and press [ENTER].

3. Press [CONTINUE] to return to specs menu. The new value(s) are entered in memory.

This procedure does NOT alter the specs on the disk. When new specs are selected (or shut power "OFF" or press [RESET]), the changes will be erased.

Technical and Customer Reports

Technical Reports

At the end of Comprehensive testing the operator may choose to print Technical and/or Customer Reports. The operator can also print reports by selecting "Results" from the Automatic Tests menu. The reports will be printed with dealer identification and customer information headings.

The Technical Report is in two sections (see Figure 158):

```
*****************************************************
*                    TECHNICAL REPORT                 *
*                 COMPREHENSIVE DATA                  *
*****************************************************

          ****** ON-BOARD COMPUTER TESTS ******

TEST NOT REQUESTED

                ****** VISUAL TESTS ******

AIR FILTER              PASS
HOSES                   PASS
RADIATOR                PASS
COOLANT                 PASS
ENGINE OIL              PASS
EXHAUST SYSTEM          PASS
DRIVE BELTS             PASS
BATTERY CABLES          PASS

    TEST                TEST RESULT          SPECIFICATION
                                             MIN.   NOM.   MAX.

               ****** BATTERY TESTS ******

1. CURRENT DRAIN          .1  A
2. OCV                  18.74 V              12.0    -      -
3. LOAD V.              10.98 V               -      -      -
4. CCA AT 105.2 DEG F.    559  CCA            -     630     -

              ****** CRANKING SYSTEM ******

5. BATT V.              11.44 VOLT            -      9.6
6. CURRENT              186.2 AMP             -     200     -
7. VACUUM                52.9  IN.            -      -      -
8. DWELL                 N/U
9. SPEED                 274   RPM            -      -      -
10. COIL INPUT V.         .0   VOLT           -      -      -
11. HYDROCARBONS           52  PPM            -      -      -

              ****** CHARGING SYSTEM ******

12. REG. VOLT           13.77 V              13.4    -     14.6
13. ALT. CURRENT         60.6 AMP             -      -      -
14. CHARGING PATTERN          GOOD

              ****** PRIMARY IGNITION ******

15. COIL INPUT V.         .0  VOLT           -      -      -
16. COIL PRI. RES.       N/U
17. BALLAST RES.         N/U
18. AVG. DWELL           N/U
19. DWELL VAR            N/U

               ****** TIMING TESTS ******

20. BASIC TIMING RPM        0  RPM           -     700     -
21. BASIC TIMING          + .0 BTDC          -      4  .0   -
22. MECH. ADVANCE
23. VACUUM ADVANCE       ADVANCE TESTS NOT REQUIRED
24. TOTAL ADVANCE
```

Figure 158

Comprehensive Data:
This section shows test results arranged according to vehicle systems. For example, all information concerning the fuel system is presented under a single heading. Specifications appear in a column next to test results. This allows quick comparison of test results with spec data.

Diagnostic Results:
This part of the report lists "Diagnostic Messages." These messages provide information about vehicle problems, according to the Comprehensive Data collected during testing. Across from each message are the line numbers of the relevant data (see Comprehensive Data section of the report).

In the following "Diagnostic Messages" section of this manual, all messages are listed alphabetically. After each message is a full explanation, along with service tips and suggestions for further diagnosis.

If the operator did not enter specifications for the vehicle tested, the analyzer cannot make a diagnosis for most vehicle systems. "OUT OF SPEC" or a similar message will appear.

Continued...

Technical and Customer Reports (continued)

Customer Reports

The Customer Report is designed to be used as a selling aid. It includes the dealer identification and customer information headings. The report is written in easy-to-understand language, suitable for presentation to a customer (see Figure 159).

```
*****************************************************************
*                        CUSTOMER REPORT                        *
*                      DIAGNOSTIC RESULTS                       *
*****************************************************************

            ****** ON-BOARD COMPUTER TESTS ******

TEST NOT REQUESTED

                  ****** VISUAL TESTS ******

AIR FILTER - PASS

COOLING/HEATING SYSTEM HOSES - ALL PASS

RADIATOR - PASS

COOLANT FLUID - PASS

ENGINE OIL - PASS

EXHAUST SYSTEM - PASS

DRIVE BELTS - ALL PASS

BATTERY CABLES - PASS

                   ****** BATTERY TESTS ******

GOOD BATTERY - PASSED ALL COMPUTER TESTS

                  ****** CRANKING SYSTEM ******

GOOD CRANKING SYSTEM - PASS ALL COMPUTER TESTS

                  ****** CHARGING SYSTEM ******

CHARGING SYSTEM GOOD - PASSED ALL COMPUTER TESTS

                  ****** PRIMARY IGNITION ******

NOT USED

                    ****** TIMING TESTS ******

THE TIMING TEST IS NOT APPLICABLE TO THIS VEHICLE

                 ****** SECONDARY IGNITION ******

SECONDARY IGNITION SYSTEM GOOD - PASSED ALL COMPUTER TESTS

                    ****** FUEL SYSTEM ******

FUEL SYSTEM GOOD - PASSED ALL COMPUTER TESTS

               ****** CYLINDER PERFORMANCE ******

ENGINE SYSTEM - PASSED ALL COMPUTER TESTS


ALL INSPECTIONS AND TEST RESULTS APPLICABLE AS OF THE
DATE AND TIME SHOWN. RESULTS MAY DIFFER AT LATER DATE
DUE TO ADDED VEHICLE SERVICE, ADJUSTMENTS AND/OR
MILEAGE.

*****************************************************************
        ******** COPYRIGHT SEAR AUTOMOTIVE 1987 ********
```

Figure 159

Printer Buffer

The Printer Buffer is completely automatic in operation. It accepts information from the analyzer at high speed, and sends the information to the printer at printing speed. The analyzer can continue to work without waiting for the printer to finish a report. When the "CONTINUE" prompt appears, the analyzer is ready for use, even if the reports are still being printed. Lengthy reports may still cause a brief pause in analyzer operation, however.

Diagnostic Messages

The analyzer computer compares vehicle performance (measured during testing) to the vehicle's specifications. Based on this comparison, the computer generates a series of diagnostic messages which are printed out on technical and customer reports. These messages generally indicate what probably needs to be serviced. The operator should use his experience along with the messages to pinpoint vehicle problems.

This section of the operating instructions lists all diagnostic messages contained in computer memory. The messages will appear in alphabetical order in this manual. Following each message is a short discussion of what triggered the message and some suggestions and hints to further pinpoint the problem.

DIS Messages — messages that will appear only after DIS Comprehensive testing are listed separately at the end of the "Diagnostic Messages" section.

Tips For Using Diagnostic Messages

1. Review the test data that triggered each message to understand what is happening in each vehicle system. Each diagnostic message that appears in the "Diagnostic Results" section of the Technical Report has a number printed after it. The number refers to the line numbers of the "Comprehensive Data" section of the Technical Report. Look at the lines indicated to see relevant data.

2. If test data seems OK, incorrect specifications may have been entered for the Comprehensive Test. To check, select "Specifications" from the Automatic Testing menu and review specifications.

3. Find the diagnostic messages in this section of the manual and consider the recommendations listed for each message.

Diagnostic Messages

ABNORMAL SPARK PLUG SNAP KV, CYLINDER XX; CHECK SPARK PLUG CONDITION FOR FOULED PLUG:	Based on snap KV measurements, one or more cylinders had abnormal KV requirements. This is probably caused by a fouled spark plug. For further testing, use Power Check or Ignition Patterns.
ABNORMAL SPARK PLUG VOLTAGE CHANGE, CYLINDER XX; CHECK SPARK PLUG WIRE:	Based on KV measurements, one or more cylinders had abnormal KV requirements. This is probably caused by a bad wire. Also check Spark Plugs. For further testing, use the Ignition Patterns or Multimeter.
ADJUST FAST IDLE SPEED:	Based on fast idle speed and specification information, the fast idle speed is not set to manufacturer's specification and is outside the +/- 100 RPM tolerance for vehicle specified. For further testing, use Adjustment screen.
ADJUST IDLE SPEED:	Based on curb idle and specification information, the idle speed is outside the manufacturer's recommendations for the vehicle specified. This message will also occur if the transmission was not in the proper gear, as specified by the vehicle manufacturer, when the test was done. Some computer-equipped vehicles prevent correction of this message. For further testing, use Adjustment screen.
ALL SPARK PLUG SNAP KV HIGH; CHECK COIL, COIL WIRE CONNECTIONS, DISTRIBUTOR CAP TERMINAL AND ROTOR:	Based on snap KV measurements, all or most cylinders had high plug firing KV. This indicates a problem "common" to all cylinders; such as the cap, coil wire or lean mixture. The problem could also be caused by worn plugs. For further testing, use Ignition Patterns or Multimeter.
ALL SPARK PLUG AVERAGE KV LOW (SECONDARY DIAGNOSTIC MAY BE AFFECTED BY RICH FUEL PROBLEM); CHECK RICH MIXTURE, COIL PRIMARY WIRING AND COIL WIRE CONNECTIONS:	Based on KV measurements, all cylinders averaged low plug firing KV, indicating fouled or worn plugs. Distributor cap problems, very rich or lean mixtures, and some types of plug wire problems can also cause a plug to look bad when it is not. Also inspect spark plugs. For further testing, use Adjustment screen or Multimeter.

ALL SPARK PLUG FIRING KV LOW; CHECK FOR REVERSED COIL PRIMARY AND FOULED PLUGS:	If the primary wires are connected in reverse to the coil, all plugs will have very low KV requirements. Remember coils can also be labeled wrong, or mixture very rich. For further testing, use Ignition Patterns Test.
ALTERNATOR PATTERN BAD; SERVICE ALTERNATOR:	The alternator pattern was tested and, based on diode information, found to be bad. For further testing, use the Charging Test.
AVERAGE DWELL OUT OF LIMIT; ADJUST DWELL AND TIMING:	Based on idle dwell and specification information, the dwell has exceeded the manufacturer's min/max tolerance, and requires adjustment. When dwell is changed, timing will also change requiring adjustment. For further testing, use Adjustment screen.
BALLAST RESISTANCE OUT OF LIMIT; CHECK BALLAST RESISTOR OR CIRCUIT WIRING:	Based on ballast resistance and specification information (no ballast resistor specified) excessive resistance was noted. Check the connections of the primary battery circuit. For further testing, use Multimeter.
BASIC TIMING OUT OF LIMIT; TEST AND ADJUST:	Based on timing and specification information, the basic timing does not equal the manufacturer's specification (plus an allowable tolerance) for vehicle specified. (***NOTE:*** On computer-equipped vehicles timing is not correctable in many cases.) For further testing, use Timing Test.
BATTERY CCA LOW FOR VEHICLE APPLICATION:	Using the displayed battery test and vehicle specification information, the computer has determined that the CCA for the battery tested is below manufacturer's minimum for vehicle specified. For further testing, use Battery Test.
BATTERY CONDITION FAULTY:	Using the displayed battery test information along with other data, the computer has determined that the battery is in need of replacement. For further testing, use Battery Test.
BATTERY CONDITION GOOD:	Using the displayed battery test information, the computer determined that the battery has passed a series of tests.

BATTERY CONDITION MARGINAL:	Using the displayed battery test information, the computer determined that the battery is no longer reliable and will fail. It requires replacement in the not-too-distant future. For further testing, use Battery Test.
BATTERY CURRENT DRAIN - HIGH:	The computer has determined that there is a small current drain from the battery when the key is off. Common items to check include trunk light, hood light, glove box light and the like. For further testing, use Multimeter.
BATTERY GOOD BUT LOW IN CHARGE:	The battery has passed a series of tests, but requires recharging. For further testing, use Charging Test or Multimeter.
BATTERY TEST INCOMPLETE:	The battery test was not performed and, as a result, additional tests which require battery information cannot be done. Use the Battery Test to obtain the missing data.
CHARGE AND RETEST BATTERY:	Using the displayed battery test information, the computer has determined that the battery's state of charge does not allow proper testing to be done. The battery must be charged and retested to determine its condition. (***NOTE:*** If this message occurs a second time, the battery should be considered marginal.) For further information, use Battery Test.
CHARGING SYSTEM GOOD:	The charging system passed a series of tests; no problem found.
CHARGING TESTS INCOMPLETE:	If charging tests were skipped or aborted, this message cautions the operator that they were not done.
CIRCUIT GAP OR SPARK PLUG KV HIGH; CHECK COIL WIRE, DISTRIBUTOR CAP TERMINAL AND ROTOR:	Based on KV measurements, all or most of the engine cylinders had a demand for excessive KV's. This usually indicates a problem "common" to all cylinders such as cap, coil wire or lean mixture. Also inspect spark plugs. For further testing, use Ignition Patterns or Multimeter.

CO INCREASE EXCESSIVE AT CRUISE; CHECK CARBURETOR, FUEL INJECTION AND INTAKE AIR SYSTEM:	Based on CO, CO_2, O_2 and other information, the mixture became rich as the throttle was opened slightly. For further testing, use Adjustment screen.
COIL KV OUTPUT LOW; CHECK COIL, COIL WIRE, DISTRIBUTOR CAP AND ROTOR:	Based on KV measurements, insufficient KV is being produced by the coil. Use Multimeter to test coil and coil wire. Also examine distributor cap and rotor. For further testing, use Ignition Patterns.
CRANKING COIL OUTPUT KV LOW; CHECK COIL, COIL WIRE, DISTRIBUTOR CAP, AND ROTOR:	Based on battery test and KV information, the coil output KV at cranking is insufficient to start vehicle. Can be caused by ignition primary problem which must be corrected first.
CRANKING HC LOW - FUEL DELIVERY PROBLEM; CHECK FUEL FILTER, FUEL PUMP, FUEL INJECTORS, CARBURETOR FLOAT AND FUEL LINES:	No-start message based on cranking HC, cranking RPM and battery test information, insufficient HC (fuel) was detected during engine cranking and the engine did not start. Since the function of a catalytic converter is to burn excessive HC, this message during No Start could be caused by converter action. For further testing, use Adjustment screen.
CRANKING PRIMARY IGNITION MISSING; CHECK DISTRIBUTOR PICKUP, IGNITION MODULE AND PRIMARY CIRCUIT WIRING:	No-start message based on cranking speed, cranking current, and battery test information, no ignition primary action occurred during cranking. This problem will also cause "Secondary Ignition Problem" to be displayed. For further testing, use the Dwell/Tach Test or the Multimeter.
CRANKING SPEED LOW AND CURRENT ABNORMAL; CHECK STARTER RELAY, NEUTRAL SAFETY SWITCH, STARTER CABLES AND CIRCUIT WIRING:	No-start message based on cranking speed, cranking current, and battery test information, there is insufficient cranking speed and abnormal cranking current. For further testing, use Cranking Test or Multimeter.
CRANKING SPEED LOW; CHECK STARTER WIRE CONNECTIONS AND STARTER CIRCUIT:	Based on cranking speed, cranking current and battery test information, the starter requires abnormally low current; cranking speed is also low. Look for loose starter cables or excessive corrosion. For further information, use Multimeter.
CRANKING SYSTEM GOOD:	The cranking system passed a series of tests; no problem found.

CRANKING TEST INCOMPLETE:	Based on cranking compression information, the engine dieseled during the cranking test. As a result, the compression data became faulty and is not provided. (***NOTE:*** This message can also occur if the cranking test could not be performed.) For further testing, re-do the Cranking Test.
CRANKING VACUUM LOW - CHECK FOR VACUUM LEAK; ENGINE MECHANICAL OR VALVE TRAIN PROBLEM:	No-Start Test... Based on cranking vacuum, speed and timing, there was insufficient engine vacuum during cranking to allow fuel to be drawn into the combustion chamber. Look for timing chain problems and fuel-washed cylinder walls.
CRANKING VOLTS LOW AT BATTERY; CHECK BATTERY CONNECTIONS AND CABLE CONDITION:	Based on cranking coil input voltage and cranking battery voltage information, during engine cranking the battery voltage was below the manufacturer's recommended minimum for the vehicle specified.
CRANKING VOLTS LOW AT COIL; CHECK CONNECTIONS, BYPASS CIRCUIT AND IGNITION SWITCH:	Based on cranking coil input voltage and cranking battery voltage, excessive voltage drop during engine cranking was detected between the battery and the coil positive. For further testing, use the Multimeter.
DISTRIBUTOR CAM VARIATION HIGH; CHECK FOR WORN OR LOOSE DISTRIBUTOR, FAULTY POINTS OR IGNITION MODULE:	Based on individual cylinder dwell, excessive variation exists from cylinder to cylinder. For further testing, use Secondary KV and Dwell or Ignition Patterns.
FAULTY COMPRESSION, CYLINDER XX; CHECK RINGS, VALVES AND HEAD GASKET:	Based on cranking compression data and RPM change, the cylinder compression is bad and cylinder has failed the Power Check.
FUEL ANALYSIS MAY BE AFFECTED BY FAILED EXHAUST SYSTEM:	Failed visual test.
FUEL SYSTEM GOOD:	The fuel system passed a series of tests; no problem was found.
FUEL SYSTEM TEST INCOMPLETE:	If the fuel system tests were skipped or aborted, this message cautions the operator that they were not done.
HIGH HC AT CRUISE; CHECK INTERMITTENT IGNITION MISFIRE, EGR, VACUUM LEAK AND TIMING ADVANCE:	Based on exhaust gas values, a problem exists in the emissions control system. For further testing, use Adjustment screen.

HIGH HC AT IDLE; CHECK INTERMITTENT IGNITION MISFIRE, EGR, VACUUM LEAK AND WORN ENGINE:	Based on exhaust gas values and other information, a problem exists in the emissions control system. For further testing, use Adjustment screen.
HIGH RESISTANCE BETWEEN BATTERY AND COIL; CHECK COIL WIRING AND CIRCUIT CONNECTIONS:	Based on ballast resistance and specification information (no ballast resistor listed), excessive resistance exists between battery and coil. Check connections of the primary ballast circuit. For further testing, use Multimeter.
IGNITION TIMING GOOD:	Based on total advance, mechanical advance and basic timing information, no ignition timing problem was found.
MECHANICAL ADVANCE OUT OF LIMIT; CHECK ADVANCE MECHANISM:	Based on mechanical advance and specification information, there is abnormal mechanical advance as compared to manufacturer's specifications for the vehicle specified. Look for worn or sticking advance weights. For further testing, use the Timing Test or Adjustment screen.
MIXTURE LEAN AT IDLE; CHECK MIXTURE ADJUSTMENT, VACUUM LEAK, INJECTION SYSTEM OR CARBURETOR (FUEL DIAGNOSTIC MAY BE AFFECTED BY SECONDARY IGNITION PROBLEM):	Based on Idle HC, CO, CO_2, O_2, and other information, the idle air/fuel ratio is too lean for good idle performance. Review the KV and Power Check tests to determine if lean idle condition is result of secondary ignition problem. For further information, use Exhaust Gas Analysis or Rough Idle Test.
MIXTURE LEAN AT CRUISE; CHECK CARBURETOR ENRICHMENT SYSTEM, FUEL INJECTION, VACUUM LEAK AND EGR:	Based on HC, O_2, CO_2, CO and other information, between idle and high speed the air/fuel mixture has become lean. Look for main metering (high speed circuit) carburetor problems. For further testing, use Adjustment screen.
MIXTURE LEAN AT IDLE; CHECK MIXTURE ADJUSTMENT, VACUUM LEAK AND INJECTION SYSTEM OR CARBURETOR:	Based on Idle HC, CO, CO_2, O_2 and other information, the idle air/fuel ratio is too lean for good idle performance. Review the data and make adjustments if possible to obtain the lowest exhaust emissions with the best idle condition. If the vehicle is air pump or pulse air equipped, these should be disconnected prior to any adjustments. For further testing, use Adjustment screen.

MIXTURE RICH AT IDLE (HIGH HC MAY INDICATE A POSSIBLE VACUUM LEAK MASKED BY RICH MIXTURE); CHECK MIXTURE ADJUSTMENT, CHOKE, AIR FILTER ASSEMBLY, PCV SYSTEM AND FUEL INJECTION SYSTEM OR CARBURETOR:	Based on idle CO, CO_2, O_2, and other information, the idle air/fuel ratio is too rich for good idle performance and economy. Examine vacuum hoses and perform Vacuum Test to determine if rich mixture is the result of a vacuum problem. For further testing, use the Adjustment screen.
MIXTURE RICH AT IDLE; CHECK MIXTURE ADJUSTMENT, CHOKE, AIR FILTER ASSEMBLY, PCV SYSTEM AND FUEL INJECTION SYSTEM OR CARBURETOR:	Based on idle CO, CO_2, O_2, and other information, the idle air/fuel ratio is too rich for good idle performance and economy. Review the data and make adjustments, if possible, to obtain the lowest exhaust emissions with the best idle condition. If the vehicle is air pump or pulse air equipped, these should be disconnected prior to any adjustments. For further testing, use the Adjustment screen.
NO ALTERNATOR OUTPUT VOLTAGE; CHECK BELT TENSION, ALTERNATOR, CIRCUIT WIRING AND REGULATOR:	Based on regulator voltage, the charging voltage is below the battery open circuit voltage. For further testing, use Multimeter or Charging Test.
OXYGEN HIGH, CHECK EXHAUST PROBE:	Based on information from the exhaust gas analyzer, a condition exists which indicates the exhaust probe has fallen out of the vehicle tailpipe. For further testing, use Adjustment screen.
POOR COIL PERFORMANCE; CHECK COIL SECONDARY, CONDENSER AND CIRCUIT:	Based on idle coil input voltage, idle coil output voltage, ballast resistance, battery test and idle dwell, the coil or condenser appear to be faulty. This message prevents most spark plug diagnostics from being done accurately. Look for a coil with a bad secondary, low input volts or a faulty condenser before repairing other ignition items. For further testing, use Multimeter or Primary Circuit Test.
POWER CHECK GOOD:	The vehicle passed a series of power check tests; no problem was found.
POWER CHECK INCOMPLETE: POWER OUTPUT LOW WITH LOW IDLE	If Power Check test is aborted, this message cautions operator that test was not done.

VACUUM, CYLINDER XX; CHECK SPARK PLUG, WIRE, CAP, ROTOR, VACUUM LEAK AND EGR:	Based on idle vacuum, compression data and RPM change, the engine vacuum is low and cylinder has failed the Power Check.
POWER OUTPUT LOW WITH LOW IDLE VACUUM, CYLINDER XX; CHECK VACUUM LEAK AND EGR:	Based on idle vacuum, compression data and RPM change, the engine vacuum is low and cylinder has failed the Power Check.
POWER OUTPUT LOW IN FIRING ORDER, CYLINDER XX; CHECK SPARK PLUG, PLUG WIRE, CAP, ROTOR AND CROSSED WIRES:	Based on cranking compression data and RPM change, one or more cylinders have low RPM drop in Power Check.
POWER OUTPUT LOW IN FIRING ORDER, CYLINDER XX; CHECK CROSSED IGNITION WIRES, VACUUM LEAK, VALVE OPERATION AND EGR:	Based on cranking compression data and RPM change, two cylinders adjacent in the firing order have low RPM drop in Power Check.
POWER OUTPUT LOW, ADJACENT CYLINDERS XX; CHECK EGR, VACUUM LEAK AND VALVE OPERATION:	Based on RPM change, two cylinders adjacent in the engine layout have low RPM drop in Power Check. Ignition problem could also be at fault.
POWER OUTPUT LOW, CYLINDER XX; CHECK FOR VACUUM LEAK AND VALVE OPERATION:	Based on cranking compression data and RPM change, the compression is good but the power output of the cylinder is low. Check for ignition problems and vacuum leaks for cause.
POWER OUTPUT LOW, CYLINDER XX; CHECK SPARK PLUG, PLUG WIRE, CAP AND ROTOR:	Based on cranking compression data and RPM change, the compression is good but the power output of the cylinder is low.
POWER OUTPUT LOW; ADJACENT CYLINDERS XX; CHECK SPARK PLUG, PLUG WIRE, CAP, ROTOR, EGR, VACUUM LEAK AND VALVE OPERATION:	Based on RPM change, two cylinders adjacent in the engine layout have low RPM drop in Power Check. Ignition problem could also be at fault.
POWER OUTPUT RESULTS MAY BE AFFECTED BY LEAN FUEL MIXTURE; CHECK MIXTURE ADJUSTMENT AND VACUUM LEAK:	The power output is low on more than one cylinder and mixture is lean at idle.
PRIMARY COIL RESISTANCE OUT OF LIMIT; CHECK COIL CONNECTIONS AND COIL CONDITION:	Based on coil primary resistance and specification information, the resistance of the coil primary has exceeded the manufacturer's recommended maximum tolerance (corrected for temperature) for the specified vehicle. For further testing, use Multimeter.

PRIMARY IGNITION GOOD:	The primary ignition passed a series of tests; no problem was found.
PRIMARY TEST INCOMPLETE:	If the Primary Test was skipped or aborted, this message cautions the operator that it was not done.
REGULATOR VOLTS HIGH; CHECK AND TEST REGULATOR CIRCUIT WIRING:	Based on diodes, regulator voltage and specification information, the regulator volts are higher than manufacturer's recommended maximum for the vehicle specified. For further testing, use the Charging Test or Multimeter.
REGULATOR VOLTS LOW; CHECK BELT TENSION, REGULATOR SETTING, FIELD CIRCUIT:	Based on diodes, regulator voltage and specification information, the charging volts are below manufacturer's minimum for the vehicle specified. The alternator diodes are good. For further testing, use Charging Test or Multimeter.
SECONDARY CIRCUIT GAP VOLTAGE HIGH, CYLINDER XX; CHECK SPARK PLUG WIRE:	Based on high plug KV and high circuit gap KV, one or more cylinders had high KV requirements. This is probably caused by a bad wire or other item which creates a secondary series gap. For further testing, use the Ignition Patterns or Multimeter
SECONDARY IGNITION GOOD:	Based on plug KV, circuit gap KV, max. /min KV, snap KV and specification information, the secondary ignition appears to be good; no problem found.
SECONDARY IGNITION RESULTS MAY BE AFFECTED BY IGNITION TIMING PROBLEM:	Use Timing Test to correct ignition timing problem. For further testing, use Ignition Patterns.
SECONDARY IGNITION RESULTS MAY BE AFFECTED BY LOW IDLE VACUUM; CHECK VACUUM SOURCE, VACUUM LEAK AND ENGINE MECHANICAL CONDITION:	Use Vacuum and Timing Tests for further testing.
SECONDARY IGNITION TESTS INCOMPLETE:	Because snap KV and circuit gap KV are missing, the KV test was aborted. Possible bad ignition coil. For further testing, use Ignition Patterns or Secondary KV tests.

SECONDARY KV CHANGE HIGH, CYLINDER XX (SECONDARY DIAGNOSTIC MAY BE AFFECTED BY LEAN FUEL PROBLEM); CHECK SPARK PLUG:	One or more cylinders did not pass the Secondary Ignition test, and a lean fuel problem exists. For further testing, use Ignition Patterns or Adjustment screen.
SECONDARY KV CHANGE HIGH, CYLINDER XX; CHECK SPARK PLUG:	One or more cylinders did not pass the Secondary Ignition test, which indicates a plug is faulty or has excessive KV requirements. For further testing, use Ignition Patterns or Multimeter.
SPARK PLUG AVERAGE KV LOW, CYLINDER XX (KV MAY BE AFFECTED BY LOW COMPRESSION); CHECK SPARK PLUG, PLUG WIRE AND DISTRIBUTOR CAP TERMINAL:	Based on KV measurements and compression information, one or more cylinders had low plug firing KV which indicates a plug is faulty. However, distributor cap problems, very rich or lean mixtures and some types of plug wire problems can also cause a plug to look bad when it is not. For further testing, use Ignition Patterns or Multimeter.
SPARK PLUG AVERAGE KV LOW, CYLINDER XX; CHECK SPARK PLUG, PLUG WIRE AND DISTRIBUTOR CAP TERMINAL:	Based on KV measurements, one or more cylinders had, as an average, low plug firing KV. Plugs are the most common cause of this message. However, distributor cap problems, very rich or lean mixtures, and some types of plug wire problems can also cause a plug to look bad when it is not. For further information, use Ignition Patterns or Multimeter.
SPARK PLUG SNAP KV LOW, CYLINDER XX (MAY BE AFFECTED BY LOW COMPRESSION); CHECK SPARK PLUG, DISTRIBUTOR CAP AND PLUG WIRE:	Based on KV measurements and compression test, one or more cylinders had low plug firing KV which may indicate a faulty plug wire, fouled plug or distributor cap problem. For further testing, use Power Check, Ignition Patterns or Multimeter.
SPARK PLUG SNAP KV LOW, CYLINDER XX; CHECK SPARK PLUG, DISTRIBUTOR CAP AND PLUG WIRE:	Based on KV measurements, one or more cylinders had low plug firing KV. Plugs are the most common cause of this message. However, distributor cap problems, very rich or lean mixtures and some types of plug wire problems can also cause a plug to look bad when it is not. For further testing, use Ignition Patterns or Multimeter.

SPARK PLUG SNAP KV HIGH, CYLINDER XX; CHECK SPARK PLUG, DISTRIBUTOR CAP TERMINAL AND PLUG WIRE:	Based on snap KV measurements, one or more cylinders had high plug firing KV. Check for faulty plug wires, faulty spark plugs and distributor terminal problems. For further testing, use Ignition Patterns or Multimeter.
STARTER BAD; CHECK FOR PROPER APPLICATION AND REPAIR OR REPLACE:	Based on the battery test, cranking current, and cranking battery voltage information, the vehicle starter has failed the conditions established for both a heavy duty and standard duty starter. Replace starter. For further testing, use Cranking Test and Multimeter.
TEST PRIMARY CIRCUIT RESISTANCE; COIL PRIMARY AND BALLAST:	Based on primary resistance and ballast resistance, the primary circuit appeared faulty on a vehicle with long dwell. A manual service test must be performed to locate the exact cause. For further testing, use Multimeter.
TIMING SYSTEM OK	
TIMING TEST INCOMPLETE:	The timing tests were skipped during Comprehensive testing. To obtain timing information, use Timing Test.
TOTAL ADVANCE LOW; CHECK VACUUM SOURCE, ADVANCE MECHANISM OR CONTROL SYSTEM:	Based on total advance and specification information, there is insufficient vacuum advance, causing low total advance, as compared to manufacturer's specifications for the vehicle specified. For further testing, use the Timing Test.
VACUUM DECREASE EXCESSIVE AT CRUISE; CHECK EGR, RESTRICTED EXHAUST AND FAULTY CONVERTER:	Based on idle vacuum, cruise vacuum sinks below specified level. Check for exhaust restriction. For further testing, use Adjustment screen.

Continued...

D.I.S. Messages

ALL SPARKPLUG COMPRESSION AVG KV LOW - SECONDARY DIAGNOSTICS MAY BE AFFECTED BY RICH FUEL MIXTURE PROBLEM - CHECK - FUEL MANAGEMENT SYSTEM - COIL, WIRING AND CONNECTIONS:	Since the low compression KV is common to all the cylinders, the problem is probably common to all the cylinders. Check on-board computer codes to diagnose fuel management systems, on vehicles where applicable. Use Emissions Test Data to check fuel system. If vehicle has single-point injection, use Lab Scope to check injector. Use Multimeter to check primary ignition system.
BATTERY CCA LOW FOR VEHICLE APPLICATION:	The battery CCA (Cold Cranking Amps) is too low for the requirements of the vehicle.
CO INCREASE EXCESSIVE AT CRUISE - CHECK FUEL MANAGEMENT SYSTEM - FUEL INJECTION - AIR INTAKE SYSTEM - O_2 SENSOR:	Based on CO, CO_2, O_2 and other information, the mixture became rich as the throttle was opened slightly. Check on-board computer codes to diagnose fuel management systems, on vehicles where applicable. For further testing, use Adjustment screen. Use Lab Scope to check injectors.
COMPRESSION AVG KV AND EXHAUST AVG KV EQUAL IN ADJACENT CYLINDERS X , X IN ENGINE LAYOUT; CHECK FOR CROSSED PLUG-WIRES AT THE PLUGS OR AT THE COIL:	KV in this pair of cylinders indicates possible crossed plug wires. Select the correct polarity setup at the beginning of the comprehensive test.
COMPRESSION AVG KV HIGH AND EXHAUST AVG KV HIGH CYLINDER X , X; CHECK PLUG-WIRE - WORN PLUG:	Compression and Exhaust KV are high for this cylinder, indicating a problem in the secondary ignition system. For further testing, use Ignition Patterns.
COMPRESSION AVG KV HIGH CYLINDER X, X; CHECK WORN PLUG - PLUG WIRE:	The compression KV for this cylinder was high, and no fuel problems showed up in the emissions test. So there is probably a problem with the secondary ignition system. For further testing, use Ignition Patterns and Multimeter.
COMPRESSION AVG KV LOW CYLINDER X,X; CHECK COIL - PLUG WIRE - OR PLUG:	Low compression KV in this cylinder indicates a secondary ignition problem. Use Ignition Patterns to pinpoint the problem. For further testing, use Multimeter.

COMPRESSION AVERAGE KV LOW CYLINDER X,X; KV MAY BE AFFECTED BY LOW COMPRESSION - CHECK - SPARK PLUG - PLUG WIRE - COMPRESSION:	Secondary KV test shows low compression KV for this cylinder. Cranking Test indicates there may be a compression problem. Use Ignition Patterns to check the secondary ignition circuit. Use Cranking Test to check for compression problems.
COMPRESSION AVG KV LOW CYLINDERS XX OF THE SAME COIL - CHECK - CROSSED PLUG WIRES - COIL - PLUGS:	Low compression KV in this pair of cylinders indicates possible crossed plug wires. Select the correct polarity setup at the beginning of the comprehensive test. If neither of these are the problem, use Ignition Patterns to check ignition system. Look for shorted plug or too small spark plug gap.
CRANKING COILS OUTPUT KV LOW ALL COILS, CHECK -COIL- COIL CONNECTIONS - PLUG-WIRES - CRANK SENSOR - CAM SENSOR:	No-start based on battery test and KV information, the output KV of all coil units at cranking is not sufficient to start vehicle.
CRANKING HC LOW - FUEL DELIVERY PROBLEM - CHECK FUEL FILTER - FUEL PUMP - FUEL INJECTORS (DROP CARBURETOR FLOAT) - FUEL LINES:	No-start because insufficient HC (fuel) was detected during engine cranking. Since it is the function of a catalytic converter to burn excessive HC, this message during No Start could be caused by converter action. For further testing, use Adjustment screen. To check injectors, use Lab Scope.
CYLINDER OUTPUT LOW ADJ. CYLINDERS IN ENGINE LAYOUT - CHECK - CROSSED PLUG-WIRES - SPARKPLUG - INJECTION SYSTEM - VACUUM LEAK - OR EGR VALVE - VALVE TRAIN OPERATION:	Two cylinders that are adjacent in the engine layout showed poor cylinder performance. This may be due to crossed plug wires. If plug wires are not crossed, check the injection system; check for vacuum leak; check EGR system. For further testing, use Ignition Patternsor Adjustment screen. To check injectors, use Lab Scope.
CYLINDER OUTPUT LOW CYLINDER X, X - CHECK - INJECTION SYSTEM - VACUUM LEAK - VALVE TRAIN OPERATION:	Based on cranking compression data and RPM change, the compression is good, and the secondary ignition system seems to be good; however, the performance of this cylinder is low. Check the injection system, and check for vacuum leak and valve train operation. For further diagnosis, use Adjustment screen. To check injectors, use Lab Scope.

CYLINDER OUTPUT LOW CYLINDER X , X - CHECK - SPARKPLUG - PLUG WIRE:	Tests show a secondary ignition problem in the same cylinder that registered low in the cylinder performance test. Look for a problem in the secondary ignition system at this cylinder. For further diagnosis, use Ignition Patterns, Cylinder Miss Recall.
CYLINDER OUTPUT LOW CYLINDER X , X - CHECK - SPARKPLUG - PLUG WIRE - FUEL INJECTOR - FUEL MANAGEMENT SYSTEM - VALVE TRAIN OPERATION:	This cylinder performs poorly; however, compression appears to be OK. Use Ignition Patterns to check ignition. Check on-board computer codes to diagnose fuel management systems, on vehicles where applicable. For further diagnosis, use Ignition Patterns, Cylinder Miss Recall, and Adjustment screen. To check injectors, use Lab Scope.
CYLINDER PERFORMANCE ACCEPTABLE:	The vehicle passed a series of power check tests; no problem was found.
EXHAUST KV HIGH CYLINDER # ___ ___ ;CHECK PLUG WIRES - SECONDARY CONNECTIONS - AND COIL:	The high exhaust KV reading for this cylinder indicates a gap in the secondary ignition system. Use Ignition Patterns to pinpoint the problem. For further information, use Multimeter.
FAULTY ENGINE VACUUM - CHECK - EGR - RESTRICTED EXHAUST - FAULTY CONVERTER:	Vacuum meter and exhaust gas values indicate there is insufficient engine manifold vacuum. Examine vacuum hoses and perform Vacuum Test. Check for exhaust restriction. For further testing, use the Adjustment screen.
FUEL SYSTEM ACCEPTABLE (GOOD):	The fuel system passed a series of tests; no problem was found.
HIGH HC AT CRUISE - CHECK - INTERMITTENT IGNITION MISFIRE - EGR - VACUUM LEAK - ELECTRONIC TIMING ADVANCE:	The fuel/air mixture is too rich at cruise. There is probably a problem in the emissions control system. Check on-board computer codes to diagnose fuel management systems, on vehicles where applicable. For further testing, use the Adjustment screen.

HIGH HC AT IDLE - CHECK SECONDARY IGNITION PROBLEM; ALSO RICH AT IDLE - CHECK - FUEL MANAGEMENT - AIR INTAKE SYSTEM - PCV SYSTEM -FUEL INJECTION SYSTEM:	Based on exhaust gas values and other information, fuel mixture is rich and there is high HC in the exhaust gases. These symptoms can be caused by intermittent misfire or other problem in secondary ignition system. May also be caused by a problem in the emissions control system. Check on-board computer codes to diagnose fuel management systems, on vehicles where applicable. For further testing, use Ignition Patterns, Cylinder Miss Recall and Adjustment screen. To check injectors, use Lab Scope.
MIXTURE LEAN AT CRUISE - CHECK - FUEL MANAGEMENT SYSTEM - FUEL INJECTION - VACUUM LEAK - EGR SYSTEM - O_2 SENSOR:	Based on HC, O_2, CO_2, CO and other information, between idle and high speed the air/fuel mixture has become lean. Check on-board computer codes to diagnose fuel management systems, on vehicles where applicable. Look for injection problems. To check injectors, use Lab Scope. For further testing, use Adjustment screen.
MIXTURE LEAN AT IDLE - CHECK FUEL MANAGEMENT SYSTEM - VACUUM LEAK - INJECTION SYSTEM:	Based on Idle HC, CO, CO_2, O_2 and other information, the idle air/fuel ratio is too lean for good idle performance. Review the data and make adjustments, if possible, to obtain the lowest exhaust emissions with the best idle condition. If the vehicle is air pump or pulse air equipped, these should be disconnected prior to any adjustments. For further testing, use Adjustment screen. Check on-board computer codes to diagnose fuel management systems, on vehicles where applicable.
MIXTURE LEAN AT IDLE - CHECK FUEL MANAGEMENT SYSTEM - VACUUM LEAK - INJECTION SYSTEM, FUEL DIAGNOSTIC MAY BE AFFECTED BY SECONDARY IGNITION PROBLEM:	Based on Idle HC, CO, CO_2, O_2 and other information, the idle air/fuel ratio is too lean for good idle performance. Before checking fuel systems, review the KV and Cylinder Performance tests to determine if lean idle condition is result of secondary ignition problem. Check on-board computer codes to diagnose fuel management systems, on vehicles where applicable. For further testing, use Adjustment screen. Use Lab Scope to check injectors.

MIXTURE RICH AT IDLE - CHECK - FUEL MANAGEMENT SYSTEM - AIR FILTER ASSEMBLY - PCV SYSTEM - FUEL INJECTION SYSTEM:	Based on idle CO, CO_2, O_2 and other information, the idle air/fuel ratio is too rich for good idle performance and economy. Check on-board computer codes to diagnose fuel management systems, on vehicles where applicable. For further testing, use the Adjustment screen. Use Lab Scope to check injectors.
MIXTURE RICH AT IDLE - HIGH HC MAY INDICATE A POSSIBLE VACUUM LEAK MASKED BY RICH MIXTURE - CHECK FUEL MANAGEMENT SYSTEM - AIR FILTER ASSEMBLY - PCV SYSTEM - FUEL INJECTION SYSTEM:	The idle air/fuel ratio is too rich for good idle performance and economy. Examine vacuum hoses and perform Vacuum Test to determine if rich mixture is the result of a vacuum problem. Check on-board computer codes to diagnose fuel management systems, on vehicles where applicable. For further testing, use the Adjustment screen. Use Lab Scope to check injectors.
NO GAS DIAGNOSTICS AVAILABLE:	Gas analyzer was not warmed up or was out of calibration during testing.
POWER OUTPUT LOW ADJACENT CYLINDERS IN FIRING ORDER CYLINDER XX - CHECK - SPARKPLUG - CROSSED PLUG WIRES:	Based on cranking compression data and RPM change, two cylinders adjacent in the firing order have low RPM drop during the cylinder performance test. This may indicate plug wires crossed at the cylinders or at the coil units.
POWER OUTPUT LOW CYLINDER X,X ALSO HIGH EXHAUST KV SAME CYLINDER - CHECK - FUEL INJECTION SYSTEM - VACUUM:	Test shows low performance in the same cylinder(s) that has a high exhaust KV reading. This indicates an irregularity in fuel flow. For further information, use vacuum test. To check injectors, use Lab Scope.
POWER OUTPUT LOW WITH LOW IDLE VACUUM CYLINDER X - CHECK - SPARKPLUG - PLUG WIRE - VACUUM LEAK - EGR - FUEL INJECTION:	Based on idle vacuum, compression data and RPM change, the engine vacuum is low at idle and the performance of this cylinder is weak. For further testing, use Adjustment screen. Ignition Patterns may also be helpful. To check injectors, use Lab Scope.
POWER OUTPUT RESULTS MAY BE AFFECTED BY LEAN FUEL MIXTURE; CHECK FUEL MANAGEMENT SYSTEM - VACUUM LEAK:	Cylinder performance is low on more than one cylinder and vacuum is weak at idle. This indicates a fuel delivery problem. Check on-board computer codes to diagnose fuel management systems, on vehicles where applicable. For further testing, use the Adjustment screen.

SECONDARY IGNITION ACCEPTABLE:	Based on plug KV, circuit gap KV, max. /min KV, snap KV and specification information, the secondary ignition appears to be good; no problem found.
TEST INCOMPLETE:	Data indicates that the cylinder performance test was not properly completed. Select Setup to make sure leads are properly connected and analyzer is getting a good trigger signal. Run cylinder performance test again.
TIMING TEST DOES NOT APPLY TO THIS SYSTEM:	Specifications indicate that the test vehicle does not have adjustable timing.

Symptoms Analysis

Symptoms Analysis is a computerized guide to troubleshooting which provides an analysis of symptoms and suggested checkpoints to help the operator determine the source of vehicle malfunctions. Symptoms Analysis may be done by itself or as a follow-up to a Comprehensive Test. If performed as a follow-up, symptoms detected during the Comprehensive Test will be included in the analysis.

How Symptoms Analysis Works

The operator tells the computer what "symptoms" or problems the vehicle demonstrates. Up to five symptoms may be entered; these range from stalling problems to the appearance of exhaust smoke. The computer asks the operator about the conditions under which the problems occur. For example: "Does the car stall only when cold? Only when warm? At all temperatures?"

When the operator has entered all observed symptoms and has responded to the computer questions, the results are computed. The computer will then print out the results of the analysis, display the results on the CRT, or exit the program, depending on the operator's selection.

The results of the analysis show:

- the symptoms entered,
- a ranked list of possible causes correlated to each symptom,
- a reference number with each cause whereby the operator may locate additional information in the Reference Manual,
- a list of suggested checkpoints for Symptoms found by A.C.E., (if Symptoms Analysis was performed in conjunction with a Comprehensive Test).

The Printout

The first item on the printout is "Symptoms Noted." This is the list of up to five symptoms selected by the operator. The symptoms appear in the order in which they were entered. (They are not ranked in any way.) Next to each symptom is a number. This number is used to identify the causes pertaining to each symptom.

Next, the printout shows the operator's response to two questions asked by the computer during the test. They identify the vehicle as:

- having either a carburetor or a fuel injection system,
- having or not having an oxygen sensor.

Under "Consider the Following Possible Causes" there are two columns: "Symptom Correlation" and "Possible Cause and Explanatory Text Number." Under "Symptom Correlation" are numbers ranging from 1 to 5. These numbers represent the "Symptoms Noted" at the top of the printout.

Listed under "Possible Cause and Explanatory Text Number" are suggested causes relating to the symptoms noted. A number follows each "possible cause." This number corresponds to an item in the Symptoms Analysis Reference. Consult the Reference to find a description of the vehicle parts involved and the symptoms a faulty part can exhibit.

Investigate one symptom at a time, checking all of that symptom's "possible causes" before moving on to another symptom. For example, investigate the list of "causes" associated with Symptom Number 1 before investigating "causes" associated with Symptom Number 2. If two or more symptom numbers occur next to a single "cause," do not assume that two or more symptoms are related. Each symptom is dealt with individually.

If Symptoms Analysis is performed as a follow-up to a Comprehensive Test, a list of problems found by the A.C.E. will appear as the last section of the printed report.

How to Use the Symptoms Analysis Reference

Look at the printout and check the list of "possible causes." After each "possible cause" is the Symptoms Analysis Reference item number. Items are listed in the Reference by number.

Selecting the Symptoms Analysis Program

Select the Symptoms Analysis program from the Automatic Tests menu. A screen listing only Symptoms Analysis as a choice will appear. This is the last point at which [BACKUP] may be used to exit Symptoms Analysis. Once the Symptoms Analysis program is entered, the operator must continue through the entire program, answering all the questions, until the final screen is reached. When this screen in reached, select "Finished With Module" (or press [REPEAT] to escape the Symptoms Analysis program; however, the "CONTINUE" and "BACKUP" keys won't work).

Choose Symptoms Analysis. The next screen presents two choices:

1. This is a follow-up to a Comprehensive Test. Results include an analysis of the problems discovered during the Comprehensive Test.

2. This is to be run as a stand-alone module. Only the selections made from the "Symptoms" screen will be considered in computing results.

The Master Symptoms Menu

The Master Symptoms menu appears next. This screen displays a list of nine symptoms or problems. Select up to five per test.

For certain problems the computer requires additional information, such as the conditions under which a problem occurs. For example, if "Starting Problem" is selected, a screen will appear presenting the following conditions:

1. Cranks OK; will not start.
2. Will not crank.
3. Cranks OK; starts hard.
4. Cranks slow.

Choose the condition which best applies.

Results

When finished making selections from the Master Symptoms menu, press [0] (No More To Enter). The next screen will list the symptoms chosen and ask if the list is correct. If "NO" is selected, the screen returns to the Master Symptoms menu and the program begins again. If "YES" is selected, the next screens present two questions:

1. Does the vehicle have a carburetor or fuel injection?
2. Does it have an oxygen sensor?

After verifying the response to these questions, the computer displays the note: "COMPUTING RESULTS ...." Wait a few moments and when the next screen appears press:

1. Results to Printer - Test results will be printed.
2. Results to CRT - Test results will be displayed on the screen.
3. Finished with Module - The screen returns to the Symptoms Analysis menu. Press [BACKUP] to return to the "Service Tests" menu or press [1] to conduct another Symptoms Analysis test.

Symptoms Analysis Reference

1 Loose Alternator Drive Belt

An alternator drive belt which is glazed, loose or in generally poor condition can affect the alternator output.

SOLUTION: Check the condition of the alternator drive belt visually; check tension by pulling on the belt.

To more thoroughly examine the belt:

1. Find the Charging Test screen located in the analyzer's Electrical Tests section.
2. Connect all leads, placing the ammeter clamp around the alternator output wire.
3. Accelerate the engine to 2000 RPM and apply a load to the battery by pressing the "REPEAT" button on the control panel.

If a reduction in alternator current is noticed, the alternator drive belt may need tightening or replacement.

2 Bad Connection Starting Circuit

If the engine cranks slowly or refuses to crank, the starting circuit may be at fault. There may be a break in the circuit (no crank) heavy resistance (slow crank) affecting the flow of electricity within the circuit.

SOLUTION: Check the system for corroded connectors and broken, unconnected or bare wires which may be grounding the circuit. Also check battery terminals for loose or corroded connections.

3 Overheating

Overheating can cause:

- slow cranking when the engine is warm,
- dragging engine due to uneven piston/cylinder expansion rates,
- dieseling or "run-on."

Engines with extremely retarded timing may overheat. Also, check the cooling system for:

- contamination,
- blocked thermostat,
- an inoperative fan.

If a reduction in alternator current is noticed, the alternator drive belt may need tightening or replacement.

4 Choke

If the choke is not working correctly, many problems may occur. The following is a list of related problems and their possible solutions:

Hard Starting: Will Not Start; Rough Idle

If the engine will not start, starts hard or idles rough, the choke may be staying on too long or may not be coming on at all.

SOLUTION: Check general choke operation when the engine is cold. Remove the air cleaner and its housing from the engine. If the choke is not closed depress the throttle until the choke closes. If the choke does not close, the choke spring or linkage may be the cause of the problem.

If the choke is closed, try to force it open by opening the throttle to its maximum limit. If the choke does not open, the unloader or similar device may need adjustment. Consult the manufacturer's information for further details.

Stalling; Backfire Through the Intake; Hesitation or Misfire
These and similar problems could be causes by a choke that pulls on at the wrong time, particularly too early.

SOLUTION: Check the fuel mixture during warm-up by selecting the Exhaust Analyzer, and watch the O_2% and CO% readings while the car is warming up. If the O_2% is above 2.5% and the CO% is less than 0.2%, the mixture is probably lean and the pull off should be modified accordingly.

Low Power; Poor Gas Mileage: Dieseling
These types of poor engine performance could be the fault of the choke and vacuum break. When the engine is stalled, the diaphragm opens the choke plate and aids starting. If the diaphragm sticks or is broken, the engine may be constantly supplied with too much fuel, causing the poor engine performance problems listed above.

SOLUTION: View the Exhaust Gas Analysis screen on the analyzer. While the engine is warming up, the CO% should read between approximately 1.5% and 6%. If the readings are out of this range, the break may be at fault. Consult manufacturer's directions for further testing and repair procedures.

5 Wrong Grade Oil

Using an oil of improper viscosity can cause cranking and starting problems in cold weather, when the oil may thicken.

SOLUTION: Check to make sure oil viscosity matches weather conditions.

6 Dirty Carburetor

A dirty carburetor can stick, jam or clog, affecting fuel flow. If the carburetor sticks or jams open, flooding can result, leading to poor mileage and hard starting. If the carburetor is clogged, sticks or jams closed, the result is fuel starvation, leading to hesitation, misfire, low power or a no-start condition.

SOLUTION: Clean the carburetor if necessary and verify that it is in good working order.

8 Accelerator Pump

An accelerator pump with a worn plunger or defective check ball may cause hesitation, misfire or stumbling during rapid acceleration.

SOLUTION: Check to see if there is resistance from a swollen or stuck plunger when the throttle plate is opened, or if the pump linkage is bent. Also look for broken or misadjusted linkage and other parts in need of cleaning or adjustment.

A quick check of the accelerator pump can be done by quickly snapping the throttle open and observing the CO% and HC readings.

To test the accelerator pump:
1. Select Emissions Test Data on the analyzer.
2. Set engine speed to about 1200 RPM.
3. Allow CO% reading to stabilize.
4. Briefly open and close the throttle with the least possible increase in engine RPM and observe the CO% and HC meters.

The CO% should increase by up to 1% and the HC should increase by up to 600 ppm. If the engine stumbles or CO% remains the same or decreases and HC increases there may be a problem with the accelerator pump.In this case the HC will also increase well before the CO%.

9 Low Compression

Low compression on one or more cylinders can be the root of many engine problems. It can be verified by testing either a weak cylinder (one reading low in comparison to others) or greatly varying cranking amperage readings.

SOLUTION: Check these items for individual cylinder problems:

- bad plug on cylinder,
- coolant in oil,
- bubbles in radiator,
- any indications of damaged valves,
- the condition ow the head gasket around the suspect cylinder.

Overall low compression may be the result of high mileage or a worn engine. The symptoms are lower than normal idle vacuum readings and higher than normal idle HC readings. Compare compression gauge readings to manufacturer's specifications to verify this condition.

10 Fast Idle

If the engine tends to misfire stall or idle rough in cold weather the fast idle cam may be sticking or operating incorrectly.

SOLUTION: The specifications for setting the cam should be displayed in the engine compartment. If the cam is adjusted correctly, check for dirt or other contamination and clean as required.

If the engine is equipped with a variable venturi carburetor check the following:

- hot Idle compensator (stuck open),
- cold start enrichment system (inoperative),
- venturi valve (stuck open or closed),
- cranking enrichment system (not operating).

Check these parts and repair or replace them as needed to improve performance.

11 Cold-Start Enrichment System

Like carbureted engines, fuel injected and variable venturi carbureted engines need a system to supply extra fuel during starting and warm-up. This system is called *cold start enrichment* and varies between variable venturi and fuel injected engines.

Fuel Injection Systems

Fuel injection systems enrich through the use of three main components:

- the cold start valve,
- the time/temperature switch,
- the auxiliary air regulator or by-pass valve.

The cold start valve is an extra fuel injector which supplies all cylinders with a richer mixture for starting. Controlled by a time/temperature switch, this valve injects extra fuel for a specified time before it is shut off. If the engine temperature is too high, the switch will not open the valve. Then, the auxiliary air regulator or by-pass valve takes over to give the engine a fast idle. The by-pass valve opens an extra passage in the intake, delivering air until the bi-metal spring in the cold start valve heats up, closing the passage and lowering engine speed.

If the cold start valve is faulty, any of these problems may occur:

- hard starting or no start,
- backfiring through the intake during cranking,
- engine starting, then dying,
- rough or unstable idle,
- incorrect idle speed,
- erratic running including stumbling, hesitation, or surging,
- incorrect CO% reading,
- poor gas mileage.

If the auxiliary air regulator or by-pass valve is faulty, the following problems may occur:

- hard starting or no start,
- engine starting, then dying,
- rough or unstable idle.

Leaks in the air intake system can also cause problems with the cold start enrichment system.

SOLUTION: Follow manufacturer's recommended service procedures for testing, repairing or replacing any defective system components.

Variable Venturi Carburetors

The variable venturi carburetor enriches through five main components:

- cranking fuel solenoid,
- cranking fuel (temp.-sensitive) control valve,
- fast idle cam,
- control vacuum regulator valve,
- an exhaust-heated, bi-metal, coil-type choke which regulates fuel flow and the position of the venturi valve and fast idle cam.

The cranking fuel solenoid is normally closed but is opened by the "START" position of the ignition switch. It allows extra fuel to be discharged below the venturi valve only when the ignition switch is on "START" and the engine is cranking.

The cranking fuel control valve regulates the amount of fuel by sensing the fuel temperature in the fuel bowl. The valve is normally closed at about 75°F (fuel temperature).

The choke controls the cold enrichment metering rod, control vacuum regulator valve and fast idle cam to provide fast idle needed during warm-up.

The vacuum regulator valve controls vacuum and provides a larger venturi valve opening for starting. As the bi-metal coil heats up, it unwraps and the control vacuum regulator valve returns to its normal position. At the same time, the cold enrichment metering rod lowers, reducing the amount of fuel flow.

A defective cold start enrichment system can cause the following problems:

- hard starting or no start,
- backfiring through intake during cranking,
- engine starting, then dying,
- rough or unstable idle,
- incorrect idle speed,
- erratic running including stumbling, hesitation or surging.

One other problem that can cause many of the above is a sticking (open or closed) venturi valve.

SOLUTION: Use the manufacturer's recommended service procedures for testing, repair, or replacement of defective components.

12 Air Flow Meter

The air flow meter is used in engines with fuel injection systems. Working with the fuel management system, the air flow meter regulates the amount of air entering the engine. If this meter is not operating correctly it can cause the following problems:

- hard starting or no start,
- hesitation or misfiring,
- backfiring in the intake,
- poor gas mileage.

The meter may also have a built-in bypass and this could be at fault.

SOLUTION: Follow manufacturer's instructions for repair.

13 Auxiliary Air Bypass

The Auxiliary Air Bypass Valve (or Auxiliary Air Regulator) helps the performance of fuel-injected engines during warm-up. If the valve is not operating properly, the engine may be difficult to start, refuse to keep running or idle rough.

SOLUTION: Check this valve according to the manufacturer's directions.

15 Faulty Ignition Switch

If the engine refuses to crank, runs erratically or backfires, the ignition switch may be defective. Make sure the switch is working correctly and repair or replace if needed.

16. Faulty Starter

The starter may have rotated but did not transfer its energy to the engine.

SOLUTION: Check for a stripped, worn or broken gear on the starter shaft, or a thrust mechanism which does not work. Although uncommon, some of the teeth on the flywheel may be broken and need replacement.

17 Ignition Module

If the electronic ignition module is defective, the primary circuit may be affected causing stalling and backfiring.

SOLUTION: To duplicate on-road conditions during testing, heat the module with a hot air gun or other appropriate tool. Check the manufacturer's instructions before testing.

18 Intermittent Electrical Wiring

Problems with the electrical system are usually the result of faulty wiring. A loose connection, grounded circuit or incomplete (broken) circuit can prevent electricity from flowing as it should.

SOLUTION: Carefully inspect any circuit which might be causing the problem and make sure all contacts are free of contaminants and corrosion which could interrupt the flow of current.

19 T.A.C.

The T.A.C. (Thermostatic Air Cleaner) maintains intake air at a specified temperature to allow smooth engine operation and reduced emissions. The valve is located in the air cleaner inlet and is regulated by a vacuum motor, diaphram or thermostatic bulb.

Clues to a faulty T.A.C. include misfiring, hesitation, stalling or backfiring during warm-up. Since a dirty or damaged air cleaner can cause similar problems, make sure the air cleaner is in good condition and all hoses are properly routed before diagnosing T.A.C. as the problem.

SOLUTION: See the manufacturer's instructions for test procedures.

20 Contaminated Fuel

Fuel that is contaminated with water, dirt or other foreign matter can cause severe performance problems.

SOLUTION: Check the fuel system for foreign matter and, if found, try to locate the point of entry. Possible entry points include the gas tank, fuel filter and float bowl.

23 Fuel Pressure

If the fuel pressure in a fuel injected system is not at the correct level (either too high or too low), the fuel mixture may be lean or rich. Resulting problems can include stalling, low power, pinging, hesitation, misfire, rough idle or no start.

SOLUTION: Check the manufacturer's directions for diagnostic and repair procedures.

25 Valve Spring

Valve springs which do not operate properly can cause problems such as rough idle and backfiring in the exhaust.

SOLUTION: Check to see that the springs meet the manufacturer's specifications for tension height and linearity.

26 Anti-Backfire Device

Many vehicles have a valve which diverts fresh air into the intake manifold to prevent large concentrations of unburned fuel from entering the exhaust system. Large amounts of fuel could backfire in the hot exhaust pipes.

Backfiring can occur if the anti-backfire valve sticks closed or is not operating correctly. Rough idling and poor engine performance can occur if the valve sticks open (too lean a mixture).

To check the valve:

1. Remove the air supply hose from the valve.
2. Accelerate the engine to 3000 RPM and observe the pivot pin inside the valve.
3. After suddenly releasing the accelerator the pivot should be open and then closed.

SOLUTION: Check the manufacturer's specifications for more detail on test and repair procedures.

27 Diverter Valve

Most engines equipped with an air pump have a valve which sends fresh air to the exhaust system to reduce emissions. This valve directs the flow of air to either the catalytic converter or the exhaust pipe past the converter.

If backfiring in the exhaust is a problem, this valve may be the cause.

SOLUTION: Check other possible causes as well and follow the manufacturer's specifications for repair or replacement.

28 Exhaust Leak

A rich deceleration fuel mixture combined with air supplied from outside the system could backfire in the exhaust system. A leak in the exhaust system could be supplying fresh air causing the backfire.

SOLUTION: Visually check the system for leaks and repair or replace parts as needed. (If the car is equipped with a diverter valve this may be the cause of backfiring and should also be checked.)

30 Heat Riser

The heat riser (or heat control valve) is an important part of the carburetor system. Regulated by a thermal spring inside the exhaust manifold, this butterfly-type valve redirects exhaust around the carburetor to heat the fuel mixture.

The valve can become inoperative with age and when faulty, can cause rough idling, detonation and lack of power.

SOLUTION: Check the operation of this valve and lubricate with penetrating oil if needed.

32 E.G.R.

The E.G.R. (exhaust gas recirculation) system opens a pathway for a small amount of exhaust gas to circulate through the intake manifold into the engine. Regulated by an *E.G.R. valve,* this system lowers peak cylinder temperatures thus reducing oxides of nitrogen in the exhaust.

If the E.G.R. valve does not open, detonation and pinging can result from of the higher pressures resulting from higher cylinder temperatures.

There are basically two types of valves: those controlled by a vacuum and those controlled by back pressure in the exhaust system.

33 Head Gaskets

It is possible that one or more head gaskets have become cracked or dislodged, allowing coolant to leak from the block. A "blown" gasket can also admit exhaust into the system, causing extreme damage when the system pressurizes. A bad seal can cause low power on one or more cylinders causing the engine to overheat.

SOLUTION: Check to see that the gaskets are good and replace them if needed.

34 Transmission

If not working properly, the transmission can cause problems with power and gas mileage.

SOLUTION: Verify that the transmission is operating well (shifting properly, responding to changes in shift lever) and that the fluid is at the proper level and in good condition (color, texture).

35 Power Enrichment Systems

Today's engines have a system which supplies extra fuel to the engine for high engine output when it is needed. The system differs between carburetor and fuel injection systems. Fuel injection systems also will vary from one engine to another.

Most carbureted engines have an intake manifold vacuum-controlled enrichment system. When the manifold vacuum is high, the enrichment system should be off.

When the throttle opens, manifold vacuum decreases as air enters the intake. The power enrichment system supplies more fuel to the engine and keeps the air/fuel mixture steady.

If the system does not open, the engine will not get enough fuel and can hesitate, surge, backfire or stall.

If the throttle is open all the time, the engine will use too much fuel and problems will include poor mileage or smoke in the exhaust.

There are basically three types of fuel injection systems, all having their own power enrichment systems: the K-jet (continuous injection system), D-jet, and L-jet.

K-jet - has a mechanically-operated power enrichment system, controlled by the air flow meter and the fuel distributor. Throttle plate movement governs the position of the air flow meter and the plunger in the fuel distributor, controlling the mixture.

D-jet - controlled by the throttle position sensor, the electronic control unit and the manifold absolute pressure (MAP) sensor. The MAP sensor detects changes in the air flow to the engine. The throttle position sensor detects changes in fuel flow and the electronic control unit uses the two readings to time the opening and closing of the injector for maximum efficiency and power.

L-jet - also uses a throttle sensor and electronic control but uses the air flow meter as an air sensor instead of the manifold vacuum. The injector timing is controlled in a way similar to the D-jet.

SOLUTION: Refer to manufacturer's directions for complete diagnostic and repair procedures.

37 Vacuum Leak

A faulty vacuum system can cause serious trouble. When servicing a driveability complaint, be sure to check all of these possible problems:

- hose routing,
- disconnected hoses,
- leaking hoses,
- assorted air leaks.

If a whistling sound from the engine changes with varying load and speed conditions, there is a very good chance a vacuum leak exists.

SOLUTION: Check the engine using the A.C.E. Exhaust Gas Analyzer.

With the engine running, apply a liquid such as motor oil to the areas in question. If a leak exists, the engine speed will increase and the CO% reading on the analyzer will also increase. Repair this area as required.

⚠ ***WARNING:*** DO NOT use flammable liquids for this test such as gasoline or thinning fluids. Severe injury may result if you use this type of liquid.

38 Low Octane Fuel

Older engines were designed to run on a higher octane fuel than newer models. Running today's lower octane fuel in those engines can cause pinging or detonation, especially in engines with a 9-to-1 or greater compression ratio. The heat of compression and the low octane of the fuel result in detonation, causing the cylinder to fire and push the piston down before it reaches the top of its stroke. In a severe case this could damage the engine.

SOLUTION: To correct this problem, try burning a different gasoline in the engine, possibly one of the premium unleaded fuels with a higher octane rating. A slight reduction in spark advance and a richer mixture may also help.

39 Fuel, Fuel Line, Filter, Pump

The fuel, fuel line, fuel filter and fuel pump can affect the quantity and quality of fuel delivered.

SOLUTION: Check the fuel pump and fuel line for sufficient volume and pressure. If not to standard, repair this part of the system and test for other problems.

Check for system leaks, which can admit contaminants and/or affect gas mileage.

40 Air Filter

A dirty or clogged air filter can affect gas mileage and power.

SOLUTION: To test the filter, use the A.C.E. CO_2 meter. With the engine running and air cleaner on, check the CO% reading. Remove the air cleaner and re-check the reading. If the CO_2 is lower with the air cleaner off, replace the air filter.

A quick check of the air filter can be made by holding a light in the center of the filter. If the filter is not too dirty, light should be visible through it.

41 Float Level, Needle and Seat

Check the level of the float. If it is too high, the engine may flood, causing starting problems. If the float is too low, the engine may not receive enough fuel, causing such problems as backfiring and stalling. Be sure to check the float for damage (leaks. fuel absorption) and replace if it necessary.

SOLUTION: Check the needle seating. If the needle does not seat well or if it sticks open, the engine may flood or the idle may be very rough because of a constantly changing mixture. If the needle sticks, the engine may stall because of lack of fuel.

42 Leaking Manifold or Carburetor Gasket

If the complaint is rough idle, the intake manifold gasket or carburetor gasket may be leaking.

SOLUTION: Check the condition of the gaskets and replace if necessary.

The problem may also be related to a vacuum leak (see paragraph number 37).

44 Valve Adjust

The performance of the cylinders is affected by the timing of the valves and by valve train clearances. Faulty valve operation may cause rough idle or related problems.

SOLUTION: Before making any adjustments, make sure the valves are not burned or sticky and the valve springs are not weak or broken. If these defects are not present, check the valve gap and adjust according to manufacturer's specifications.

Also, check the valve timing. Generally, if the valve timing is off, the timing gears or chain must be replaced.

45 P.C.V.

To prevent oil dilution, air pollution and sludging, and to maintain engine idle, most of today's engines have a positive crankcase ventilation valve (PCV valve). The PCV valve re-routes gases from the crankcase to the carburetor intake manifold.

When a high vacuum exists in the manifold, (such as at idle conditions), the valve is closed to preserve the correct air/fuel mixture needed for idling.

Less vacuum exists in the manifold when a load is placed on the engine, allowing the valve to open and recycle the gases through the intake manifold into the engine to be burned.

This system also allows air to pass through a second hose from the air filter to the crankcase to compensate for any vacuum in the crankcase.

A faulty valve or poorly operating PCV system can lead to the following problems:

- increased oil consumption,
- oil contamination, resulting in internal engine damage,
- rough idle or stalling,
- oil dilution, resulting in poor engine lubrication,
- overflow of crankcase fumes into passenger area, leading to complaints of odors,
- Oil vapors escaping through the fill tube or dipstick tube and polluting the air

SOLUTION: A quick way to check the valve performance is to remove the valve and shake it. If the valve rattles, it may be operating properly but should be tested further to ensure proper operation. If no sound is heard, the valve may be stuck and should either be cleaned or replaced. Perform further testing to verify this result.

Another way to check valve operation is to use a device which tests air flow through the crankcase while the engine is running. The air flow is measured by an indicator inside a plastic tube. Follow manufacturer's instructions on operation of this device.

Be sure to check all hoses that are a part of the system and make sure that they are not clogged or leaking. Also, check the engine manufacturer's manual for further testing routines and specifications, as valves and systems can vary greatly.

46 Fuel Injectors

If the fuel injectors are not operating properly the engine may not be getting the right amount of fuel. This can cause many engine problems, including poor gas mileage and assorted starting and running problems.

SOLUTION: Check for worn or damaged injectors, and follow manufacturer's recommended operation instructions.

47 Seized Engine

If the engine is seized, it will not turn over or start. If the engine is hot, let it cool down before trying to re-start. A seized engine is an indication that there may be serious engine damage.

SOLUTION: Consult the manufacturer's recommendations for repairing the engine.

48 Dragging Brake

A stuck or dragging brake may cause the engine to overheat and may lower gas mileage considerably.

SOLUTION: Check the brake system, including parking brake. Make sure all wheels can turn freely.

49 Low Tire Pressure

Underinflated tires can put a strain on the engine, resulting in poor gas mileage.

SOLUTION: Check the tire pressure and add air if needed.

50 Fuel Leak

If the driveability complaint is poor gas mileage, there may be a leak in the fuel system.

SOLUTION: Check the tank, lines to the engine, fuel pump seals and all engine areas for fuel stains. Since leakage may occur only when the engine is running, drive the car and check for leaks again.

5l Oil Leakage

A leak may be the reason for apparent high oil consumption.

SOLUTION: Check the oil pump as well as all seals and gaskets for leaks. Oil leakage could be the result of a worn engine (see paragraph 55).

52 Rings

If the piston rings (apex, corner, or side seals on rotary engines) are not operating properly, oil may leak into the cylinder or rotor, causing both exhaust smoke and high oil consumption as the oil is burned. Low compression on one or more cylinders or rotors could indicate bad rings also. Check the compression on the suspect cylinders with a spark plug type gauge. If performing this test on a rotary engine, use a special gauge or a regular gauge with the Schrader valve removed.

SOLUTION: Refer to the manufacturer's instructions on repairing or replacing the rings or seals.

53 Valve Guides or Seals

If the valve guides or seals are leaking, oil may be entering the cylinder causing smoke in the exhaust, especially upon start-up or other high-vacuum conditions.

SOLUTION: Check the manufacturer's instructions for inspection and repair.

55 Worn Engine

The symptom(s) entered indicate one or more major systems in the engine need attention, possibly an overhaul or thorough repair program.

SOLUTION: Check the manufacturer's recommendations to verify this.

56 Low Coolant

An engine low on coolant may overheat. Make sure the correct amount and type of coolant specified by the manufacturer is used.

Low coolant may be the result of a leak somewhere in the cooling system.

SOLUTION: Check for leaks from the engine block or hoses. Repair or replace parts as needed.

58 Thermostat

The coolant thermostat controls the rate of coolant flow through the system. If the thermostat is stuck open, the engine may be cooler than is needed, causing poor cold weather performance and aiding sludge build-up. If the thermostat is stuck closed, the engine may be warmer than is needed, leading to carburetor flooding problems and overheating.

SOLUTION: Check the thermostat and replace if needed.

59 Water Pump

A faulty water pump will make a strange noise under the hood and can cause problems with coolant circulating through the engine block.

SOLUTION: Check the operation of the water pump and repair or replace as needed.

60 Radiator or Cap

There may be a leak in the cooling system, either in the radiator, or through the radiator cap.

SOLUTION: Check to make sure the cap fits tightly and is rated correctly for system pressure. Verify that there are no leaks from the radiator, overflow system, water pump or coolant hoses.

Check the system to make sure it pressurizes properly and that the radiator core is not plugged, causing low coolant flow.

61 Air In Cooling System

If the cooling system is not filled to capacity (or if the correct coolant is not present), the system may not be performing as it should, possibly causing engine overheating.

SOLUTION: Check that the system is filled with the manufacturer's recommended quantity and quality of coolant. Also check the cooling system for leaks and bad hoses.

62 Low Oil

If the engine is low in oil, the engine may not be operating properly. Insufficient oil can lead to severe engine damage and costly repairs.

SOLUTION: Check to make sure the oil level is correct for the engine and add if needed.

63 Carbon Deposits in Cylinder Heads

Carbon deposits in cylinder heads can cause many internal engine problems. The deposits result from burning a low octane fuel. If enough deposits build up, the actual combustion volume may be reduced. Carbon deposits can also become hot, igniting the fuel that is entering the cylinder before the piston reaches its optimum firing position. The result is detonation or pinging.

Carbon deposit accumulation can also cause dieseling or run-on after the ignition system has been turned off.

64 Overloaded Engine

If the vehicle is not in the correct gear for load and speed conditions, the engine may become overloaded and make strange noises at low RPM.

SOLUTION: Adjust gearing for different driving conditions (shift to a lower gear when the vehicle is pulling a heavy load).

65 Engine Bearings

If the engine bearings are worn, there is space between the bearing surfaces resulting in unusual noise may result.

SOLUTION: Check the condition of the bearings according to manufacturer's instructions.

67 Air Pump

The air pump supplies air to the exhaust system for burning hydrocarbons, thereby lowering emission levels. If the air pump is defective, it may make a strange noise.

SOLUTION: Check the manufacturer's procedures for testing and repairing the air pump.

69 Carburetor Linkage

If the complaint is dieseling or run-on, the carburetor throttle linkage may be the problem. Sticky or inoperative linkage could be holding the throttle open.

SOLUTION: Check the carburetor for dirty, bent or broken linkage and clean, repair or replace parts as needed.

71 Idle Solenoid

The idle solenoid is a device which controls the position of the throttle in the engine. Depending on the manufacturer, the solenoid can adjust the idle for engine load (accessories, etc.), close the throttle upon shutoff for prevention of dieseling (most common), or control the idle speed. If the solenoid is defective, it can cause problems with idling and dieseling.

SOLUTION: Test and repair or replace the solenoid as directed by the manufacturer.

75 Gross Timing Error

If engine timing has shifted significantly from normal, the engine may not start. Verify that static timing is correct. Slipped or broken timing chains or gears can cause large valve timing shifts.

SOLUTION: A loose or improperly installed distributor cap or stuck advance weights can cause ignition timing shifts.

76 Secondary Ignition Leakage

An electrical current will always follow the path of least resistance. An electrical short in the secondary circuit (coil, coil wire, distributor cap, rotor, plug wires and spark plugs) can cause three major problems:

- hard starting or inability to start,
- misfiring on one or more cylinders,
- rough idle.

If the distributor cap is wet inside or is cracked, current may leak to the grounded rotor center or to another plug.

Plug or coil wires may also be leaking to the block when it is damp, causing visible arcs. Arcing may also occur during an increase in KV demand or when cranking.

SOLUTION: Carbon lines on the rotor or distributor cap may reveal location of cracks or shorts.

77 Neutral Safety Switch

Vehicles with automatic transmissions have a device which disables the starter if the vehicle is not in neutral or park. Some vehicles with manual transmissions have a clutch pedal switch requiring the clutch to be depressed to start the engine.

If these switches are defective, the engine may refuse to crank.

SOLUTION: Check that the safety switch is working properly and repair or replace if needed.

78 Intermittent Primary Connections

A problem with the primary circuit and its connections can cause problems such as backfiring, misfiring or stumbling and stalling. On the analyzer, this would show up as a lack of primary wave oscillations.

SOLUTION: Check the following for possible interference:

- coil primary windings for excessive resistance or shorting,
- ignition switch for resistance, shorting, or loose connections,
- condenser for defects which could cause arcing points,
- battery to coil lead for breaks,
- coil to points lead for breaks,
- breaker plate for loose connection or no ground,
- frayed or broken wires along entire circuit.

On engines with electronic ignition, check these additional items:

- connections from pick-up coils to electronic ignition module,
- condition of the module.

Also, unusually high resistances along the primary circuit signal the location of a problem.

80 Bad Valves

Worn or badly operating valve systems can cause engine problems such as pinging and rough idle.

SOLUTION: Inspect the valve train for the following problems:

- Sticky valves
- Leaky valves
- Burned valves
- Weak or broken valve springs
- Abnormal cylinder compression
- Worn or damaged camshaft
- Broken rocker arm
- Bent push rod

Repair any of the above problems present in the valve train and verify cylinder performance by checking the vacuum level on each suspect cylinder.

81 Computer Fuel Management

Today's engines use a computerized fuel management system to help increase efficiency and performance. If this system is malfunctioning it can cause many driveability problems.

SOLUTION: Use the appropriate Service Test and refer to the recommended manufacturer's procedure for each individual system.

82 Ignition System

The ignition system encompasses fuel delivery, fuel ignition, combustion pressure and many other system events. A wide variety of problems may exist with any or all of these events.

SOLUTION: Monitor each event using the A.C.E. Ignition System Test.

83 Battery

If the battery is faulty, it may not be providing enough power to start the engine, leading to slow cranking or no crank at all.

SOLUTION: Use the A.C.E. Battery Test to monitor the condition of the battery.

84 Charging System

The charging system involves running the alternator to charge the battery and using the electricity produced by the engine to run accessories and other electrical systems.

SOLUTION: Use the A.C.E. Charging System Test to monitor the charging system and to help isolate the faulty engine component(s).

85 Speed Control

If the idle speed is not set correctly, there may be problems with the engine not receiving the correct amount of fuel. Hard starting, no start, rough idle, stalling, hesitation or misfire are indications idle speed may be off.

SOLUTION: Use the A.C.E. Comprehensive Test to monitor idle conditions.

86 Restricted Exhaust

If the exhaust system is restricted, there may be problems with low engine power and poor gas mileage. Changes in the intake manifold vacuum can indicate restrictions in the exhaust system.

SOLUTION: Measure the manifold vacuum at idle. The reading should be in the range of 16 to 21 inches Hg. for most engines. Rapidly increase engine speed to 2000 RPM. Vacuum should momentarily drop, then stabilize between 16 and 20 inches Hg. If the vacuum remains below 16 inches Hg., check for a blocked catalytic converter or other restriction in the exhaust system.

Perform an Emissions Test on the A.C.E. to provide further insight into the problem.