HC Diagnosis
(non-computer controlled vehicle)

Check ignition timing
(base and advance as applicable.)

Verify engine integrity
(relative compression, engine vacuum, compression)

Ignition system analysis
(firing lines, spark lines duration & slope)

Lean misfires
(intake manifold leaks, defective vacuum hoses or actuators)

Poor fuel vaporization
(plugged intake manifold cross-over, combustion chamber quench areas)

Air injection reaction (AIR) system
(switching, operating pressure)

Is the catalyst operating properly?

Tools & Techniques

Timing light, magnetic timing, tachometer, base timing specifications and timing advance specifications (if available)

Vacuum gauge / transducer diagnosis, relative compression / cylinder balance test, dry compression test

Secondary, primary ignition system oscilloscope analysis. Look at spark lines for evidence of lean mixtures / poor flame propagation (NOx failures).

Carburetor cleaner / propane, smoke machine, vacuum leak detector, lambda calculator, secondary ignition

Spark line diagnosis, cylinder balance test, digital pyrometer

AIR system operation description. Use 4/5 gas analyzer and look for O2 drop with AIR supply hose pinched off or disconnected

Manufacturer's test procedures, 4/5 gas analysis (high CO2, low O2), cranking CO2, snap O2, temperature gain, intrusive
HC Diagnosis
(computer controlled vehicle)

Refer to "High HC Non-feedback" diagnostic flowchart

DTC's?

Yes

Discern between hard and soft codes

Follow manufacturer's or published diagnostic / repair procedures for hard codes

Test O₂S with DSO

O₂S in good serviceable condition?

No

Upon repair of O₂S circuit or replacement of sensor, re-test O₂S

High frequency signal = misfire
Signal biased below 450 mV = lean mixture
Signal biased above 450 mV = rich mixture

Yes

Map O₂S signal with DSO

Tools & Techniques

Timing; mechanical, electrical lean air/fuel misfires, vaporization, AIR, catalyst

Scan tool, jumper wire, screwdriver, DTC pulling instructionis

Pull codes, record codes in the order they are displayed, erase codes, operate vehicle, pull hard codes

Scan tool, multimeter, DSO, DTC diagnostic flowcharts, diagnostic & repair information

Propane enrichment tool, DSO minimum voltage = 0 - 175mV maximum = 800 - 1000mV rate of change = < 100 mS (175mV - 800 mV)
CO Diagnosis
(non-computer controlled vehicle)

Check air intake system for restrictions

Check for unmetered fuel entering the engine

Check carburetor operation

Check air injection system operation

Check catalyst(s) operation

Tools & Techniques

Plugged / dirty air filter, improper choke operation, plugged PCV system, improper TAC operation

Improper EVAP purge operation, saturated EVAP canister, fuel contaminated engine oil (> 500 ppm HC after 5 minutes measured at the oil filler neck engine off)

Float level, choke operation, main metering, power valve, idle circuit

Use system description / operation to verify proper switching. Check operating pressure by pinching off supply hose and verifying O₂ drop in tailpipe emissions

After upstream repairs are complete, use manufacturer's procedures to test efficiency. Combinations of cranking CO₂ snap O₂, HC efficiency, temperature gain are useful when manufacturer's procedures aren't available.
CO Diagnosis
(computer controlled vehicle)

Refer to "High CO Non-Feedback" diagnostic flowchart

DTC's?

Yes
Discern between hard and soft codes

Follow manufacturer's or published diagnostic / repair procedures for hard codes

Review data stream (if available) or confirm related sensor/output performance. Test O₂S with DSO.

Check for vehicle computer operation (is the fuel metering system capable of being artificially driven rich or lean, is the timing being controlled? Perform manufacturer's recommended system performance check)

No

Refer to "High CO Non-Feedback" diagnostic flowchart

DMM, DSO, propane enrichment tool, break-out box

Tools &
Techniques

Air intake restriction, unmetered fuel, carburetor, air injection, catalyst operation

Scan tool, jumper wire, screwdriver, DTC pulling instructions

Pull codes, record codes in the order they are displayed, erase codes, operate vehicle, pull hard codes (OBD I)

Scan tool, multimeter, DCO, DTC diagnostic flowcharts, diagnostic & repair information

4/5 gas analyzer, timing light, sensor simulator

Tools &
Techniques

Air intake restriction, unmetered fuel, carburetor, air injection, catalyst operation

Scan tool, jumper wire, screwdriver, DTC pulling instructions

Pull codes, record codes in the order they are displayed, erase codes, operate vehicle, pull hard codes (OBD I)

Scan tool, multimeter, DCO, DTC diagnostic flowcharts, diagnostic & repair information

4/5 gas analyzer, timing light, sensor simulator

Tools &
Techniques

Air intake restriction, unmetered fuel, carburetor, air injection, catalyst operation

Scan tool, jumper wire, screwdriver, DTC pulling instructions

Pull codes, record codes in the order they are displayed, erase codes, operate vehicle, pull hard codes (OBD I)

Scan tool, multimeter, DCO, DTC diagnostic flowcharts, diagnostic & repair information

4/5 gas analyzer, timing light, sensor simulator
NOx Diagnosis

Check ignition timing (base and advance as applicable.)

Check exhaust gas recirculation (EGR) system (if equipped)

Check for lean air/fuel mixture

Check for excessive coolant and/or intake air temperature

Check for excessive combustion chamber pressure

Check for proper fuel octane rating

Check catalyst operation (vehicles equipped with a reduction catalyst only)

Tools & Techniques

Timing light, magnetic timing, tachometer, base timing specifications and timing advance specifications (if available)

Vacuum guage/pump, tachometer, scantool

Lambda calculator, gas analyzer, biased O2S pattern, fuel trim data, secondary ignition pattern

Pyrometer, scantool, temperature probe, thermometer

Compression guage, borescope, TSBs

Owner's manual, vehicle owner

Manufacturer's test procedures, 4/5 gas analysis (high CO2, low O2), cranking CO2, snap O2, temperature gain, intrusive
OBD II Diagnostics

MIL illuminated?

Yes

Pull DTC's and record freeze frame data

No

Follow manufacturer's or published diagnostic / repair procedures for DTC's. Begin with the DTC referred to in freeze frame data

Review pending DTC's, monitor status, mode 6 and mode 5 data, fuel trim and misfire data

Perform a system performance check and/or a complete drive cycle as per manufacturer's instructions

Check PCM for DTC's (pending or matured), review mode 6 and mode 5 data for failed test results

Tools & Techniques

MIL functional test (KOEO bulb check)

Scan tool, paper & pencil. Do not erase DTC's unless instructed to do so by diagnostic / repair procedures

Scan tool, multimeter, DSO, DTC diagnostic flowcharts, diagnostic & repair information

Scan tool

Manufacturer's or published diagnostic & repair information

Scan tool
**Diagnostic Preliminaries**

1. Vehicle fails Smog Check
2. Prepare an estimate for diagnosis
3. Obtain customer authorization
4. Verify customer complaint (baseline inspection in pre-inspection mode, training mode, manual mode or partial pre-inspection) when appropriate
5. Select a method to document diagnosis (vehicle information datasheet, tech notes, etc.)

**Diagnostic Assumptions**
- Visual inspection
- TSB's and helpful hints
- Engine integrity
- Powers and grounds

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**Post-diagnosis process**

1. Analyze diagnostic information (component test data, measurements, waveform analysis, etc.)
2. Prepare a repair strategy based on diagnostic information
3. Prepare an estimate to repair defects relative to the failure determined in the diagnosis
4. Discuss the repair strategy with the customer and obtain authorization
5. Perform authorized repairs, gauge repair effectiveness