Causes of Excessive Hydrocarbons (HC)

1. **Ignition System**
   - Poor spark (high voltage current) quality at each cylinder

2. **Ignition Timing**
   - Too advanced

3. **Lean Air / Fuel Ratios**
   - Too much air (lean misfire)
   - Not enough fuel

4. **Very Rich Air / Fuel Ratios**
   - Too much fuel
   - Not enough air

5. **EGR System Malfunctions**
   - Valve stem leaks (intake leaks)
   - Valve seat leaks (EGR at idle)
   - Too much EGR for a cylinder
   - EGR occurs too soon or abruptly
   - EGR hangs open (HC spike on decel)

6. **Engine Mechanical Problems**
   - Cylinder sealing issues
   - Low compression
   - Valve timing

7. **Faulty Catalytic Converter (Oxidation)**

8. **Restricted or plugged fuel injectors**

IM/93 Test Procedures – Service Bay Analysis Tips

DIRECTIONS:

You will need to obtain schematics for the subject vehicle you are working on in reference to testing the fuel injectors, ignition and fuel pump circuitry. All documentation should be attached to this worksheet if additional review is deemed necessary. All trouble codes must be addressed prior to beginning these series of test procedures.

Year: _____ Make: _____ Model: _____
VIN#: _____

Analyze the drive trace to see if possible trends are present

1. Check for signs of external hydrocarbons

_____
_____

2. Check for improper EGR operation

_____
_____

3. Check for possible catalytic converter failure

_____
_____

4. Check for excessive hydrocarbons in the engine oil via the gas analyzer

_____
_____

I/M Baseline Information (Pre-repair)

Obtain a Baseline for the vehicle you are working on, it is preferred that you test drive the vehicle in order to obtain this data. A brake torque performed with the transmission in reverse can be done in the event the vehicle cannot be test driven. The road test is always the preferred method.

Road test HC _____ ppm · Road test CO _____% · Road test CO2 _____%
Road test O2 _____% · Road test NOx _____ppm

TYPICAL GOOD KNOWN READINGS

HC – less than 100ppm · **CO** – less than .5% · **CO2** – between 12% and 15%
O2 between .3% and 1.3% · **NOx** – less than 1000ppm
Lambda should be .98 to 1.02

Causes of Excessive Carbon Monoxide (CO)

1. **Very Rich Air/Fuel Ratios**
   - Too much fuel

2. **Excessive fuel pressure at the injectors**
   - Fuel pressure regulator stuck
   - Restricted fuel return lines

3. **Leaking fuel injectors**

4. **Loaded / Malfunctioning EVAP system**

5. **Crankcase fuel contamination**

6. **Incorrect input signal to PCM**
   - Coolant temperature
   - Throttle position
   - O2 content
   - Load
   - Intake air temperature
   - Etc...

7. **Ruptured fuel pressure regulator diaphragm**

8. **Closed loop control system incorrectly shifted rich**

Note: Due to the reduction capability of the catalytic converter, increases in CO emissions tend to reduce NOx emissions. It is not uncommon to repair a CO emissions failure and as a result of another sub-system deficiency, have a NOx increase sufficiently to fail a loaded-mode transient test.

IM/93 Test Procedures – Service Bay Analysis Part 2

DIRECTIONS:

You will need to obtain schematics for the subject vehicle you are working on in reference to testing the fuel injectors, ignition and fuel pump circuitry. All documentation should be attached to this worksheet if additional review is deemed necessary. All trouble codes must be addressed prior to beginning these series of test procedures.

Year: _____ Make: _____ Model: _____
VIN#: _____

Analyze the drive trace to see if possible trends are present

1. **Check ignition timing:**
   - Specifications_____ ATDC or BTDC
   - Actual timing_____ ATDC or BTDC

2. **Check for fuel pump integrity:**
   - Fuel pressure specifications: _____ PSI
   - Actual fuel pressure: _____ PSI
   - Fuel volume specification: _____ GPM
   - Actual fuel volume: _____GPM
   - Fuel pump current (waveform): _____ Amps
   - Fuel pump relay test: _____ Amps
   - Fuel pump average current: _____ Amps
   - Fuel pump speed: _____ RP
   - Fuel pump integrity: PASS or FAIL

3. **Check EGR system for proper operation:**
   - EGR valve: PASS or FAIL
   - EGR passages: PASS or FAIL

4. **Check PCV operation**
5. **Check the Air Management System for proper operation** PASS or FAIL
6. **Check EVAP/PURGE for proper operation** PASS or FAIL

Causes of Excessive Oxides of Nitrogen Nox

1. **Cooling system problems**
   - Insufficient radiator airflow
   - Low coolant level
   - Poor cooling fan operation
   - Thermostat stuck closed or restricted
   - Internal radiator restriction

2. **Excessive lean air/fuel mixture**
   - Leaking intake manifold gasket
   - Worn throttle shaft

3. **Closed loop control system incorrectly shifted lean**

4. **Improper oxygen sensor operation**
   - Slow rich to lean
   - Rich biased O2 sensor voltage

5. **Improper operation of EGR system**
   - Restricted EGR passages
   - EGR valve inoperative (mechanical or electrical)
   - Leaking misrouted EGR hoses
   - Vehicle not in closed loop
   - EGR solenoid inoperative

6. **Carbon deposits**
   - Intake valve deposits
   - Top of piston (increased compression)

Additional Checklist for Nox Failures

1. **Engine out measurement with vehicle in fuel control (no EGR)**
   · 2000 – 4000 PPM (Pre-catalyst)

2. **Engine out measurement with vehicle in fuel control (with EGR)**
   · 1100 – 1200 PPM (Pre-catalyst)
   · 40% to 60% reduction

3. **Post catalyst measurement with vehicle in fuel control (with EGR)**
   · Less than 1000 PPM (well under 500 PPM on good running engines)

NOx will peak when lambda equals 1.05 to 1.10, all good running engines will produce Nox. A good baseline approach for testing Nox is stated below:

1. Always start your analysis by addressing HC and CO first, Nox second

2. Baseline the vehicle. Use a gas analyzer on a road test to simulate an IM 93 test to measure Nox. At the very least, load the engine in the service bay while measuring NOx. NOTE: The IM 93 test peaks at 35 MPH.

3. Verify fuel control. Check gas analyzer lambda and test the and test the oxygen sensor for proper operation.

4. Observe fuel trims. Improper fuel trim can indicate an error with airflow measurement (load). Timing and EGR control can be affected by an inaccurate load measurement.

5. Test the EGR system for COMPLETE flow.

6. Test the catalytic converter's ability to reduce NOx.

7. Perform a fuel injection cleaning and/or engine decarbon treatment if intake valve or combustion chamber deposits are suspected.