Engine Tune and Performance: Symptoms

FAQ Home

Volvo Maintenance FAQ for 7xx/9xx/90 Cars

Abbreviations

Note: Symptoms may involve several potential failures, so diagnosis should start with a general perusal of this entire section. Most of these notes apply to Bosch LH 2.2 and LH2.4-equipped cars. Regina-equipped cars have some differences in components and component failure patterns. Where known, these are noted in the relevent section. Symptoms for B6304 engines used in the Volvo 960/90 series cars with Bosch Motronic are covered in a separate 960 file. Diesel symptoms are covered in the diesel file. Some notes relate to carburetted cars: they are identified as such.

General Symptoms and B2XX Series Engines:

Don't Panic: Diagnose First Before Concluding the Worst!

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Poor Idle, Idle Surge and Hunt: Cleaning Your Throttle Body

Poor Idle, TB Cleaned, now idle to high

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No or Poor Cold Start: Problem Diagnosis and Repair

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Unexplained Driveability Problems: Rotten Battery Cables

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Rich-Running Problems:

Rich Running Problems: General Diagnostic Notes

Car Stalls; Bad FPR Likely Cause

Car Stalls During Turn; Bad Fuel Pre-Pump Likely Cause

Poor Performance; Rich Mixture Smell: Diagnostics; Faulty FPR

Poor Perfomance, Bad Acceleration: Faulty FPR

Engine Hesitation: Bad FPR

Fuel in Oil: Faulty FPR or Injector

Other Running Problems:

Car Stalls Repeatedly on Startup: Fuel Pump Check Valve

Car Stalls, Lights Die: Electrical Ground Fault

Car Over-Revs RPMs While Under Acceleration

LH-2 Cold Idle Problems -Bad ECT or O2 Sensor and Wiring Harness Notes

Car Won't Start: Neutral A/T Safety Switch at Fault

Car Won't Start; Plugged Catalytic Converter

Turbo-Specific Symptoms:

Turbo has Poor Acceleration; Diagnostics

Turbo has Poor Idle, Poor Idle Speed Control: Leaking Intake Manifold Gasket

Turbo Suffers Severe Misfire: Leaking Intake System

Engine Cuts Out; Rich Running: Turbo Electrical Harness Degradation

Turbo Stalls at Low RPM: Failed CBV Valve Diaphragm

760T Misfires; FI Resistor Pack Defective

Hot Start Problems: Faulty Hall Sensor

Hot Start Problem: Power Stage Overheats

Diesel Engine Symptoms. See Diesel section

960/90-Specific Symptoms. See 960 section

960 No-Start: Sticking Valves

960 Stalls: Wiring Harness

960: Transmission Lights Flash, Cylinders Quit: Bad Ground

960 Sudden Idle Surge: ECT Sensor Failure

[Editor: 960/90 series cars suffer from numerous wiring and electrical troubles, all explained in the 960 section

Emission Control Problems (High HC, CO, NOx):

Emission Control Problems: High HC, CO or NOx

Abbreviations:

AMM	Air Mass Meter
ECT	Engine Coolant Temperature sensor
ECU	Engine Control Unit computer (either fuel injection or ignition)
FI	Fuel Injection
FPR	Fuel Pressure Regulator
IAC	Idle Air Control solenoid valve
TB	Throttle Body
TPS	Throttle Position Sensor
VSS	Vehicle Speed Sensor

Don't Panic: Diagnose First Before Concluding the Worst! [Editor] Volvo engines are quite robust and the four cylinder, eight valve versions are virtually indestructible. Below is an email from Colombia with a typical story:

> *Dear Brickboarders: I am once again in the need for advice/opinions from you. I recently got very bad news from the dealer: my 940 Turbo engine, with 62k miles needs to be rebuilt. They say it's impossible to know how much damage is in there until they open everything up; thus, they cannot quote me. They say it can range from a new set of rings to a full rebuild, including block surfacing, new pistons, etc. What should I do? Dealer says there is no test to determine the state of the engine, they didn't even perform a compression test. They claim the engine needs fixing because there is air blowing out of the oil fill orifice instead of suction, and the PCV seems to be fine.*

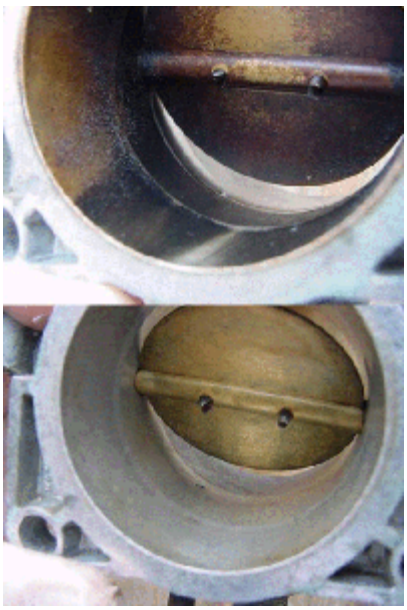
And this was the typical Brickboard response:

> *Run, don't walk away from those clowns. Read and re-read the FAQ's regarding crankcase ventilation. HIGHLY unlikely you have a ring type problem. Sounds like you need to clean (or simply remove and replace) your oil separator and all associated hoses. Please mention the name of the Dealer so we may curse them...*

The solution? Cleaning the oil separator, something that takes about one hour and some solvent. So be skeptical and do your homework.

Idle Problems:

Poor Idle, Idle Surge and Hunt: Cleaning Your Throttle Body and Your Fuel System.



Symptoms and Why You Should Regularly Clean Your Throttle Body. The throttle body regularly fouls on the throttle blade and bore. The contaminants are oil droplets from the crankcase ventilation system. Every engine generates some blowby (gases blowing past the rings) - especially turbos. When the crankcase ventilation system routes these gases into the throttle housing, they carry oil residue with them. When this oily residue strikes the hot throttle blade, it condenses out due to reduced pressure and temperature inside the bore and cokes it with nasty, varnishlike deposits that restrict airflow around the throttle blade. Although the ECU tries to compensate for this restriction by tweaking the idle air control valve (IAC), it often can't compensate enough- hence, the driveability symptoms. Cleaning the throttle body often fixes the following driveability problems:

- stalling on deceleration
- rolling idle

- rough idle (hot or cold)
- off-idle or tip-in hesitation
- stalling just once, when the driver shifts into gear first thing in the morning
- sticking throttle in subfreezing weather (which may cause a no-start)

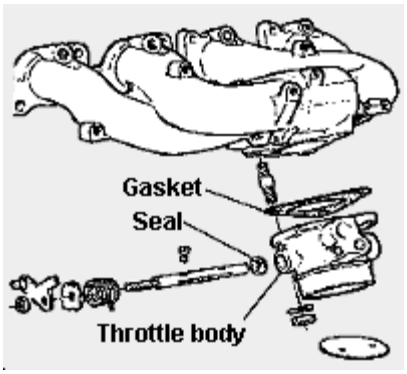
Note that contaminated throttle bodies do not set OBD trouble codes relating to these symptoms, so you need to consider a cleaning first if these symptoms begin. Make this a regular procedure every year.

First Clean the Fuel System. Before you take apart the throttle body, add a bottle of Techron or equivalent fuel system cleaner to your tank. The symptoms above can be caused by deposits on your fuel injector nozzles. Drive the car through the tank and then decide if you also need to clean the throttle body.

Tools and Supplies Needed for Throttle Body. You will need a new throttle body paper gasket (cheap, from the dealer); an old toothbrush or bottle brush; and a reputable spray cleaning chemical marked "fuel injection cleaner". Using regular spray carburetor cleaner, for example, can erode protective coatings on the throttle shaft or destroy a plastic TPS housing. Tools: flat blade screwdriver to remove the air intake hose clamps, a combination wrench to remove the three nuts secure the TB, and pliers to loosen the pinch spring clips on vacuum hoses.

Special Note on Use of Solvent Cleaners. [Larry Carley, Brake and Front End Magazine, Dec 02] Using conventional aerosol carburetor cleaning solvents on fuel injection throttle plates, for example, can be an extremely expensive mistake. Although strong solvents instantly dissolve gum, varnish and carbon from throttle plates and bores, they also dissolve throttle shaft seals, throttle position sensors or (when applicable) the Teflon from the air inlet horn! Nevertheless, specially formulated throttle body solvents do as good of a job without causing potential driveability complaints. Most are also good for cleaning delicate import carburetors for the same reason. Unlike killer carb cleaners, throttle body solvents don't cause comebacks by eating away at delicate switches, potentiometers and neoprene diaphragms found on import carburetors. Most throttle-body aerosols also spray in the inverted position for cleaning hard-to-reach components.

Cleaning Procedure. [Illustration copyright RPR, used by permission]



- Disconnect the wiring harness from the throttle switch by compressing the wire bail on the connector body, then pulling the connector straight away.
- Disconnect the three rubber vacuum lines. Two have spring hose clips which must be compressed to loosen and pull off.
- Disconnect the throttle actuator rod by using a small flat-bladed screwdriver to gently pry away the little locking tab on the end of the lower ball-and-socket. Use a flashlight to see it better. (The plastic ends which have the socket & ball attachment on the link rod can break when they are removed from an old or very cold engine, so be very gentle and don't work on a frigid piece of cold plastic. Get replacements from the dealer. One is a right-hand thread, the other left-hand.)

- Unscrew the three nuts holding the TB on to the intake manifold. You may need a magnet here if you drop one.
- Remove the throttle body from the intake manifold. The gasket on my car lifted right off with no fuss, but if you have to scrape be sure to use a plastic or wood scraper so as not to damage the aluminum facing. You can reuse the gasket if it is in good shape. Better to replace it if old.
- Clean the entire throat and the throttle plate paying particular attention to the edges and pivot points to make sure it can close completely. Use an old tooth brush and spray fuel injection (not carburetor) cleaner. Don't spray the cleaner on the black plastic TPS. Remove the base idle black adjusting knob if so equipped and blow out that passageway and blow out another bypassing passageway that you will see in the throat. [Norm Cook] If you don't have compressed air, take this base idle boss off and pour solvent in to soak. The internal passage is quite small and engine oil easily plugs it. Clean out the tiny vacuum holes in the fittings that lead to the vacuum tubes which may be completely plugged.. If you don't have an air compressor to blow out the passages, use the spray tube on the FI cleaner can for that. Of course you will want to clean the outside of the throttle body so it will look nice. Assemble in reverse of disassembly. The holding nuts go on tight enough to prevent air leaks at the gasket, but don't overdo the torque in the aluminum manifold. I like to lube the ball-and-socket ends to free them up next time I clean the TB.

Notes on TPS Adjustments.

- Do not remove the TPS when cleaning the throttle body. If the TPS or idle speed need adjustment, see the information in Throttle Body and Throttle Position Switch Adjustment. But if you can't help yourself -- take a small screwdriver or other object that will make a fine scratch and scribe a line across the edge of the throttle sensor switch's flange and it's mounting bracket, right where the Allen screws hold it tight. Doing so will get you in the ballpark when it's time for reassembly. After re-assembly, be sure to check for the click when the throttle butterfly comes off its stop: you should hear a distinct click RIGHT as the throttle is just opened, noting the switch is signalling the ECU the engine wants off idle NOW. If this switch is even slightly slow, so will your off idle response. If no click at all, you may find your engine running at higher rpms at idle since the ECU does not pick up the "idle" signal.
- The mechanical throttle butterfly blade stop is a setscrew on the forward side of the TB aimed up. It has a nut (8 mm, I think) on the underside. It's right near the big coil spring that turns the throttle to idle. When you turn the throttle and allow it to return to idle position, you can see a small arm bear against this setscrew.
- The throttle switch is on the backside of the TB, opposite the setscrew, and is locked by two small screws. It has an electrical cable plugged into it.
- With the TB off the car, I first loosened the switch so it didn't inadvertently act as a stop (very bad for the switch!). I backed the setscrew out until the throttle butterfly plate was completely, jammed shut. Then I turned the setscrew in until it just touched the arm, and another 1/4 turn. This takes the mechanical force off the butterfly, so when the throttle slams shut, it doesn't wear the butterfly or damage the switch. Don't forget to tighten the locknut, and then recheck the adjustment -- tightening the locknut can change the screw position slightly.

- Then, with the throttle at idle position (the spring forces it there), you carefully turn the switch until it goes click. Tighten the two screws. Be sure, as you rotate the throttle (TB still in your hands) you can clearly hear the switch click and that it does it while the arm is maybe 0.030" off the setscrew.

Notes on Idle Speed Adjustments [Gregg Stade]:

[**Adjustment of Pre-89 TB, TPS and Base Idle**:]

The p/n's for the gaskets you will need are 1271488 and 463766. There is an o-ring on the black knob (pre-'89 only) that you will have to remove to thoroughly clean the housing p/n 947114. Do not remove the throttle cable, but with a small screwdriver unclip the small plastic linkage lock from the throttle body and swing it up , then disconnect the throttle switch . After the housing has been cleaned the throttle stop is adjusted. Loosen the 8mm lock nut and back out the screw, turn the screw back in just till it contacts the lever. Rotate the screw another 90 degrees and lock it down. Install the throttle switch and rotate it till it clicks with the throttle plate closed. Lock it down, the switch should make a click as soon as the throttle plate is moved . Test it several times in your hand at varying opening speeds make any fine adjustments now. BTW don't loose the o-ring on the switch if you remove it; it is not available as a spare part. With the housing back on the car, adjust the linkage rod so that the throttle plate doesn't move when it is hooked back up. After everything is hooked back up there are two more things to do. First, adjust the cable with the threaded piece at the throttle bobbin. You just want a little slack. Second, base idle has to be reset.

(Pre-1989 only:) For this, you will need a tach/dwell meter. You need to read engine rpm. Warm the engine to operating temp. Here s the tricky part. There is a blue connector behind the battery with nothing plugged into it . There should be a blue/white wire in the connector. Ground this wire it shuts off the idle speed motor so that base idle can be adjusted with the black knob on the throttle housing. Base idle for this car should be 700 rpm. When the ground lead is disconnected the idle should go up to 750rpm's +/- 20 rpm's.

[**More on Setting Base Idle Rate**:] Just adjusting the base idle by the set screw is not a good idea. First, you must check to make sure the throttle housing is clean from oil deposits, as above. Upon re-assembly, the base idle set screw must be backed off, then turned in till it just touches the housing. You want to turn the screw 1/2 turn then lock it down with the 8mm nut. Remount the throttle position switch and rotate it just so it clicks then lock it down. In 1989, Volvo did away with the black idle speed screw, everything is controlled by the fuel ECM .If the throttle plate doesn't return completely and energize the TP switch, the fuel ECM doesn't know the throttle has returned to idle.

Poor Idle; TB Cleaned; Now Idle is Too High.

[Inquiry:] Well my problem is certainly gone. It now idles at 1600 rpm, but that's a steady 1600. Did I do something wrong, or was the crud in the throttle body masking another problem?

[Response: Evan] Nope, the crud WAS the problem. Crud makes the car idle lousy and slow. Lazy mechanics simply dial up the idle to mask the problem, rather than

fixing it. You just need to dial the idle back to spec. On the end of the butterfly shaft, the end where the spring is, there's a stamped metal plate. It has a 'leg' bent down that rests against the idle stop screw. The screw is held in place with a lock nut. loosen the nut and adjust the screw. [See Throttle Body and Throttle Position Switch Adjustment for more detail on 89+ cars and Adjustment of Pre-89 TB, TPS and Base Idle: for pre-89] Be careful, the screw head has a tendency to strip out. In retrospect, you should have taken a minute to make sure the screw was free while the TB was on the bench.

Another thought: Before you do any of the above, make sure that the 'leg' on the stamped metal plate actually touches the stop screw at idle. Some REALLY lazy mechanics just adjust the throttle cable length at the big obvious pulley, rather than adjust the stop screw

Notes on TB Disassembly:

[**Tips on reassembly of TB shaft spring**:] I carefully took the spring off the side of the throttle body, noticing that it was under tension... one full turn, but alas... I forgot to note if it was under tension one full turn CLOCKWISE or COUNTER CLOCKWISE. [Response:] The throttle body spring, attached to the throttle body lug that goes into the throttle body and points out from the throttle body to the radiator goes CLOCKWISE! The spring has a little bent-out stop that catches under the idle adjustment screw. You put the spring on so that catches... twist the dang thing one turn clockwise, put your nut on, attach the throttle control rod and it's done.

Poor idle, Smoke, Oil Leaks: Clogged Flame Trap [Symptoms:] Smoke out the tailpipe, gradual oil loss, fouled plugs, valve cover gasket or main oil seal leakage. [Tip: Bob Savasta, Motor Magazine, Jul y 2001] These are classic symptoms of a bad PCV or flame trap system, which is clogged with sludge or carbon.

Fuel Intake Carbon Removal.

Problems With Valve and Injector Deposits. [Motor Magazine, Dec 2002] As a vehicle approaches higher mileage, you can generally expect intake valve deposits (IVDs) and injector deposits. Their onset can vary widely, depending on driving conditions. Engine operating temperature, intake manifold gas speed (rpm) and hot soak cycles are some of the critical operating parameters affecting these deposits. To lubricate an intake valve, tiny amounts of oil have to run down the valve stem. Over time, this oil is deposited and heated on the intake side of the valve, forming a carbon cone. This has multiple effects on the intake event. The carbon changes the aerodynamics of the intake event - causing higher gas speed and a change in the direction of intake and swirl - which affects the combustion process. The IVDs also act like a sponge, creating a delay in fuel control. This delay not only creates a temporary enleanment on acceleration but also causes a temporary enrichment on deceleration. When the throttle is closed, the intake manifold vacuum goes high, pulling the fuel out of the carbon sponge. This affects fuel control. When the engine is shut off, a small amount of liquid fuel is left on the tips of the injectors; this fuel evaporates and leaves behind solids that were originally dissolved in the fuel). Eventually, these deposits cause an injector to act like a squirt gun rather than an

atomizer. Aggressive drivers and drivers with long highway drive cycles may not have deposit issues until very high mileages. Stop and go drivers, especially delivery drivers with many hot-soak cycles, are more likely to experience deposit problems sooner.

See the FAQ Section on Fuels and Lubricants for more information.

Carbon Removal in Injectors, Intake Manifold, Valves and Cylinders:

Gasolines with Detergents. In the United States, the new Top Tier gasolines are certified to have adequate detergent levels to remove intake system deposits as determined by the Top Tier group of GM, BMW, Honda, and Toyota. See their website at http://www.toptiergas.com/

Gasoline Additives. BG44K is the heavy duty stuff - and recommended in Volvo and BMW TSB for removing carbon deposits, particularly from intake valves and fuel injectors. Use no more often than 2/yr, and only 1/yr if your system is in reasonable condition. Pour the can in the gas tank only with the tank full. Use it when you will be able to drive out a tank of gas in a day or two. Plan on changing the oil and filter soon after use as it can contaminate the oil with unwanted chemicals. Distributor at website: http://www.bgprod.com . Other effective products include Chevron's Techron, STP's Complete gas treatment, and GM Top Engine Cleaner. Using these cleaners in conjunction with an "Italian Tuneup" (driving at high rpms while the engine is fully warmed up) is frequently very effective. [Caution from Zippy] Volvo specifically recommends AGAINST using any fuel or oil additives. I know they used to suggest it was okay, but then decided that catalytic converter damage is done when additives are used. Since about 1993 gasoline improvements have made additives unnecessary.

Cleaning Machines. Snap-On decoking machine (reported very effective by Robert Price) It does clean injectors but it removes carbon better! Also, try Motorvac (a variation on the Sun machine.) Other techniques include walnut shell blasting/flushing (many sources of good success) in a shop with the equipment, most often a BMW specialist.

Injector Cleaning. See the FAQ section in Engine: Fuel Injection for tips on injector cleaning.

Combustion Chamber Deposit Removal. See the FAQ section in Engine: Mechanical for a water-based technique that works, although using it with turbos may be a bad idea.

Engine Dies After Starting, Won't Idle; Needs Intake Cleaning. My '85 with 230F had a similar problem. It would die after starting and put into gear when cold and Idle was not stable. Here's what I did to fix it:

- Replaced all vacuum hoses and checked for vacuum leaks.
- Removed and cleaned air control valve.
- Removed and cleaned throttle body in fuel carb cleaner, replaced all gaskets.

At this point it was running better but not perfect.

- Adjusted throttle body linkage and throttle position sensor per the book. It has to be done in sequence
- Ran a can of BG44K through the tank to clean up intake valve and fuel system deposits.

Car now runs very strong.

Poor Idle: Injectors Need Cleaning. See Injector Cleaning for more information on how to solve chronic idle problems due to dirty injectors.

Poor Cold Idle: B230F/T ECU E-Prom Needs Update.

[Inquiry] My wife's 95 945T (90k miles) starts fine on a cold (below 40F) start, but idles like crap for 20 to 30 seconds. If I hold my foot on the gas and keep it at 1500 rpm for 8 to 10 seconds, its fine. Car idles nicely when warm, and runs like a dream. When I pull the plugs, they look great. I've replaced ECT and other parts and cleaned the TB.

[Response: Abe Crombie] Go to a dealer and have them look at Volvo Service Bulletin 28-102 modified e-prom for cold start with low rvp fuel. This says the symptoms are: car starts and then immediately dies and requires re-start. Runs rough for the first 45 seconds and may hesitate on acceleration. Recent EPA regulations have necessitated changes in the formulations of gasolines (i.e. oxygenated fuels). The result of these reformulations has been a decrease in the relative vapor pressures (volatilities) of these fuels, which seems to be particularly problematic for cold starts/idling. The updated eprom chip to be installed in the ECU is the fix to make it have correct fuel mixture computations for cold start. You must have the number from your ECU in order to cross-reference the correct eprom update kit P/N. The change procedure described in 28-102 requires careful attention to static discharge.

Idle Speed Control Problems.

High or Unstable Idle. [Symptom] My 945T (94 - 99k) has been having high/low idle problems - it wanted to idle around 400 or 1500+ - there was no middle ground. [Solution] Replace the throttle position switch, which detects idle when the switch is closed and, if faulty, will cause idle problems.

Idle Speed Control on Late 7xx/9xx. In Volvo 700/900 cars with LH2.4 fuel injection, the idle speed is controlled by a bypass system. When your foot is off the gas, the throttle plate is fully closed and a separate idle air control valve admits the required amount of air to get the engine to idle at 750 rpm. This separate valve is controlled by the computer. No adjustments are possible.

Start or Stall Problems:

No Start; Frequent Stall or Hesitation: Basic Diagnostics. [Inquiry:] I have an 88 740 non turbo 150k miles. Intermittently the engine will stall typically at lower

speeds or idle. It will not restart unless I turn off the ignition and back on again as if this resets something (the computer?). Also there is a stumble or miss when starting out from a stop. This is fairly consistent. Another symptom is that intermittently at cruising speed of say 60mph the engine appears to cut out for only a half second, this will continue several times a minute until I shut off the engine and restart. Plugs and wires good, throttle body clean, fuel pressure OK, O2 sensor OK, have checked all connectors that are easy to get at. It appears that the computer sometimes gets out of whack for some reason and wants to be reset. Any suggestions?

Basic Diagnostic and Preventive Maintenance Checklist [from Paul Grimshaw/David Hunter] You've either got a fuel or spark problem. Here is a basic diagnostic checklist:

1. Watch the tach carefully when a stall occurs. If it drops to 0 even before the engine winds down then that would indicate loss of ignition pulses to the coil negative terminal. Primary suspects would be the power stage or the crank position sensor. If tach tracks the engine speed as it winds down then that would indicate a fuel injection problem. Suspect radio supression relay or loss of fuel pressure due to relay or pump.
2. Confirm condition of distributor cap, rotor, spark plug wires and spark plugs. If *all* of these have not been replaced in the past two years with OEM or better (ie. higher quality ~ more expensive), do so now. (Yeah, I know that you have not yet determined that the problem is spark related, but there's no sense troubleshooting a problem unless the basic bits of maintenance are completed and certified correct).
3. Remove each spark plug, ground the threaded base against the engine block and, with the spark plug wire connected to *only that plug*, have a friend crank the engine. You should see a spark. If not, there is a problem with spark delivery. Repeat with each plug/wire. Note: In most cases, its not the spark but the fuel. That said, any failure to complete basic maintenance on your engine will only lead to a poor running engine and multiple, intermittent faults.
4. If your have not replaced the fuel filter in the past 3 years, do so now. The fuel filter/fuel pump is located under the passenger footwell (driver's side). Replacing the filter is not a particularly difficult job for the experienced shade tree mechanic with a complete set of hand tools. If you're unsure of your experience level or tool crib, have the job done professionally. Ensure that the sub-assembly is completely cleaned and dried before disassembly as FI systems do not react well to ingested dirt. It will require Volvo PN 1389562-8. While you're replacing filters, don't forget the air filter -- you engine will always run better with a new one of these! Again, a bit of basic maintenance that should never be skipped.
5. If you lack a fuel pressure gauge capable of reading fuel pressure to at least 400 kpa and lacking the proper fittings, true troubleshooting will be difficult. Your car's LH system is supposed to operate at a constant 300 kpa.
6. Lacking the proper diagnostic equipment, your only solution will be to replace each component until the problem is solved. I won't list all of the possible problem components as most situations are traced back to either the main fuel pump or the pressure regulator. Use a long piece of hose to listen for the main fuel pump as the car is being cranked. If you cannot hear the fuel pump turn, check the voltage using a VOM.

7. If all is well, skip to the fuel pressure regulator. Replace the unit with Volvo PN 1389564-4, but may also be replaced by Bendix PN 4088942-0001.
8. If the car now runs, but frequently requires long periods of cranking to start, then suspect the check valve in the fuel pump. The check valve is a threaded in-line valve that maintains line pressure between 200-300 kpa after the engine is shut off.
9. If the car still does not start, check the fuel pump relay. If in doubt, replace it with Volvo PN 3523608-3.
10. If the car will not re-start while warm, check the radio suppression relay and the rpm sensor (LH2.4) or Hall sensor (LH 2.2).
11. If the car stalls while hot, check the ignition power stage amplifier which is cooled through body contact. [Bruce Young] Check also the ground connector for the radio suppression relay at the fender ground plane which can corrode, interrupt the circuit, and shut off power to injectors.
12. **Regina-Equipped Cars:** Check as well the coil pack and MAP sensor.
13. Conclusion. The beauty in the approach listed is that you first complete the basic maintenance required; car's just won't run well without regular maintenance! Second, you're using a rudimentary tool (the hose) to check for fuel pump operation. That's important since the fuel pump is a very expensive piece of gear that you would not really wish to replace unless it is dead. Third, there's some merit in repair by replacement, especially if you lack the proper fuel system diagnostic equipment. The pressure regulator is about $40 buck and, with age, will eventually die anyway. So replacing it just saves you being stranded at some point in time. Finally, the pump relay is the next most likely culprit. [Editor's Note: See the notes below about rpm or Hall sensor and radio suppression relays; these can also be frequent culprits.]
14. Hope this helps. Remember the merits of maintenance before trying to solve any recurring problem.

Basic Ignition and Fuel Injection Component Diagnostics. My '87 740 GLE routinely dies. My mechanic tells me there is no injector pulse with the hall effects switch or the fuel injection control unit being the most likely causes. Is there any way to test these components?

[Tips from Bob Dietz] When the car dies run a test light from the negative side of the coil to ground. If the light flashes brightly when you bump the starter then all the ignition components are ok, and the fuel pump should run for a few seconds. If the light barely flashes and the fuel pump doesn't run, then suspect the ignition amplifier (between the air filter housing and the inner fender wall.) If the light flashes and the fuel pump doesn't run, suspect the fuel injection relay (the white relay behind the ashtray--remove the lighter, lighter cover plate, two screws and the ashtray to access). Pull the cover off and reinstall, turn the key to run position and operate the contacts by finger. If the fuel pump runs then the relay is suspect--resolder or replace--your choice. If by turning the key to start and holding the fuel pump point set closed the car runs, release finger pressure on the fuel pump contacts. If the contacts stay closed for a few seconds after you release the contacts then the relay is bad and the fuel injection control unit is ok. If the motor shuts off as soon as the fuel runs out after you take finger pressure off the relay contacts then replace the relay and the fuel control unit--the protection diode on the relay has failed and wounded the computer.

Other Component Tips:

[Tips: Mark Klein] Sounds like you've been fairly thorough already. There is a radio noise suppression relay on the coolant reservoir which can go bad and cause a variety of similar symptoms including not running at all. Be sure the fuel pump relay is in good shape. It is the white one in the 2nd row back on the far left. Check the date code printed on the side. If it is the original, it wouldn't hurt to replace it anyway. The Hall sensor sender wiring (pre-89 cars) coming out of the bottom of the distributor can short out against the distributor housing if the plastic connector breaks. This is quite common but I doubt if this is giving your symptoms. The rpm sensor on later LH 2.4 cars can also fail. The FI control unit itself can go bad. One of the more common circuits which fails is the one that grounds the fuel pump relay and, in turn, turns the fuel pump on. I doubt if an air mass meter would give the symptoms you're getting but you might try removing and reconnecting the electrical connector a few times. See also the tips in the FAQ sections below.

Wiring Shorts. [Tip from Chris L] Stalling combined with fuse 11 failures (fuse 11 supplies the fuel pump and the oxygen sensor, at least in Regina cars) can result from wiring shorts at the fuel sender unit at the tank or in the oxygen sensor heater wiring near the exhaust, which can fray and short against the pipes, causing the fuse to blow.

Carburetted Engines. See the note regarding relays below. Don't immediately conclude you need a rebuilt carburetor.

No or Slow Hot Start: Problem Diagnosis and Repair. See the attached file for a quick-reference guide to no- or slow-hot-start problems and diagnoses.

No or Poor Cold Start: Problem Diagnosis and Repair. [Editor] Assuming you have reviewed the checklist above and eliminated ignition or fuel injection components as sources of a poor cold start condition, look for vacuum leaks. Holes in the air intake hose, vacuum tubes, a failing vacuum check valve in the brake booster, a broken booster diaphragm, or a leaking intake manifold gasket can all cause your engine to fail to start or to perform very poorly once started, with fluctuating or high idle and poor tickover.

Regina System No Start or Re-Start on Cold Mornings. [Tip from Bruce Young] If your car has Regina fuel injection and you have difficulties with re-starting after the car has been sitting for half an hour or so, see the Volvo TSB 23-135 from January, 1990 regarding Cold Start Problems. Here's a summary:

- Below 23°F (—5°C) cold start difficulties...rich fuel mixture during cold start crank and warm-up
- Before chasing this down, you can tell if this TSP has been applied or not by checking the wires at the cold start injector plug. First, peel back the rubber boot. If the 2 connected wires are Gray-Black and Blue-Green, the TSP has NOT been applied. If the wires are Gray-Black and any other color (with Blue-Green cut off and taped back -- or removed --) the TSB HAS BEEN applied. NOTE: This TSB rewiring will cause a permanent 3-2-1 OBD code, but no CE

Light.
- Background: The CSI has voltage is applied from the Radio Suppression Relay, like the regular injectors do. And is controlled on the ground side by the ECU, based on temperature. The TSB changes the CSI's voltage source to an auxilliary terminal on the starter solenoid. So the CSI now gets activated only during cold cranking, rather than as soon as the key is turned on for that 1-2 second pump buzz — and all during warm-up, till warmed above the cold start temp criteria

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Intermittent No Start or No Warm Restart: Radio Suppression, FI Relay, RPM Sensor.

[Inquiry:] Sometimes the '88 749GL just won't start. It seems like it's not getting gas when this happens, but after sitting for awhile (a few hours, overnight, or occasionally just a few minutes) it starts right up like nothing is wrong.

[Editor:] If your car fails to start until after it has cooled down, the three items to check are the rpm sensor, radio suppression relay and fuel injection relay solder joints.

[Response] Try the **fuel injection relay**. Find the relay in your center console relay bank and tap it to see if this restores fuel flow (starting immediately). [Response] I have a 90 740gl that had the same problem. When you're cranking the engine and it won't start, is the tachometer needle moving a little? If not, as mine didn't, I believe you want to check into the **RPM sensor**. Check the RPM sensor located on the back of your engine, connected to the bell housing. The wire runs up the back of the engine compartment towards the drivers side. Look for the part number on the wire and check if the part number ends with 399. This rpm sensor has a heat related problem: common for it to cause a no- start but able to start a little while later. Since I replaced mine for about 30$ I haven't had the problem. [Editor: post-88 cars have this sensor; pre-88 cars have a Hall sensor inside the distributor.] The third common cause of no-hot-restart conditions is failure of the **radio suppression relay**. This relay is usually mounted beneath the coolant expansion tank and may be next to the identical coolant fan relay. You can often test it by swapping leads with the coolant fan relay, but only if the latter is working. This may not be the case in cooler regions where it is not frequently used.

Tach Needle Movement. [Chris Herbst] In all of the Bosch systems, the tach jumps when you crank the car. In the Regina systems the tach does not usually move until the car is running. I have noticed this in all the Rex ignition ('Regina') cars. Unless the car is running, the tach is normally lifeless.

If you Have a Regina System: [Chris Herbst] If you have problems with a Regina system that has an intermittent no-start:

1. Crank sensor
2. Interference relay
3. Fuel pump relay
4. Coil pack (THIS IS A BIG ONE)
5. MAP sensor. Not very expensive.
6. Regina Only: Wiring to cold start injector

Far Less Frequent But Still a Related Symptom: Ignition Amplifier. If the car will start and then die, or refuse to start again until it's cooled off, or just not start period. or just randomly die or misfire under load, then suspect a failing ignition amplifier. This is located on the driver's side fender (wing) behind the headlight.

If You Have a Turbo: Boost Overpressure Switch Failure (if so equipped). See the FAQ file.

Intermittent No Start: Fuse Contact Failure. [Tip from Roman Shestakov] I had a situation when my 1990 740 GLE just would not start. Engine turns, lights come on the dash, but does not start at all. No pre-charge noise from the fuel pump could be heard before turning the engine. After pulling out the relay tray to inspect the fuel injection relay, I found instead that fuse #1 that supplies power to ECU and fuel pump was making bad contact with connector in fuse box. Plastic around that fuse was melted and looked brown. You immediately could tell that there was an excessive heat around that fuse. Repairing it was easy. After pulling the fuse/relay assembly box out of console, remove all fuses. Take a flat screw driver and pop the fuse box upper cover out by prying on its sides (there are already slots available for that kind of tool), exposing fuse contacts. Examine the fuse contacts. Mine were all oxidized and looked very brown (heat caused copper to oxidize and made contact surface even less conductive over time) causing current to heat up the contacts. Take a small piece of sand paper (spread contacts apart with screw driver if necessary) and clean contacts inside surface from deposits until it turns copper-red like other contacts next to it. In my case, I had to scrape them with a knife as well. Then straighten contacts carefully so that they are parallel to each other and lean against each other as tight as possible, similar to undamaged fuses. Your fuel injection fuse is rated at 25A and must go in tight, or you will be facing the same problem again. Then pop the top cover back on and reinstall all fuses. Re-install everything back into console except the fuse cover box. Test drive the car for 5-10 minutes, and while you are driving, put a finger on fuse #1 and the plastic upper plate around it. It must be cool to touch.

Intermittent No Start: Water Leaking Onto Distributor.

Leaking Washer Fluid Line. [Tip] My 940 suffered from intermittent no starts until I discovered that the windshield washer fluid anti-check valve on the firewall was leaking and squirting water onto the distributor cap. A new valve, cap and rotor solved the problem.

Rain Leaking Past Failing Firewall-Hood Gasket. [Tip: Georege Pigg] My 93 940 went through a period of time where it would randomly fail to start. On one occasion the engine even quit as I was making a right turn. Looking back over all of the no starts I discovered that all of the events occurred during rainy weather. Further investigation revealed that the weather stripping seal between the rear of the hood (engine lid) and the firewall had failed. This allowed rain water to reach the distributor and the connector for the rpm sensor. After placing tape over the gap between hood and the firewall there have been no more failures to start even during rainy weather.

Intermittent No Start/Stall: Battery Ground Connector Failure.[Inquiry] My 1988 740 GLE has been having an intermittent no start problem; all other causes have been ruled out. [Tip:Dan] I would follow the battery ground cable to the block , it is just in front of and just below the oil filter. Pull on the cable hard while wiggling it. I had the same symptoms as you have and in my case that was the problem. When I just touched my cable at the block, where it went into the connector it came right off in my hand. I bought a new one of the correct length and re-routed it, instead of running back through the frame, where by the way, the plastic insulation was worn completely off to bear wire. That is what caused my start sometimes and sometimes not. See the FAQ section on corroded battery cables.[Editor] Check your engine ground straps for oxidation and corrosion.

No Start; Tear in Air Duct Intake Hose.

[Inquiry: David Smith, courtesy UK Volvo Club] For the last six months it has been getting harder to start. Up to now there has been no problem - has 170,000 miles. Fuses are OK and I replaced the distributor cap, rotor, installed a new wire set and replaced the spark plugs. I also noticed that one of the wires leading to the coil was also in very bad shape at the coil end. I snipped off some of the wire and replaced the female connector. I've been to two dealers who put it on the computer 'scope' - no problem shows up. One dealer cleaned the throttle body (dirty) and the other installed a new crank case sensor. A third dealer said it may be a poor ground (all seem OK) or a computer module. I said that nothing showed up on the computer analysis at two different dealers - and he said that it probably wasn't the module in that case. Very recently it just wouldn't start. It turned over OK and I unsuccessfully tried to jump start it from two different vehicles, a light truck and a V8 Chevy (using a good jumper set). There was spark from the plugs when turning over. We also sprayed di-ethyl ether in to the engine via the fuel injection system and engine fired OK when turned over. Tried again - turning over OK - but not starting. However, just three hours later it started up with no problem on its own and has run OK for 3 days. From what I can gather I suspect that it may be an ECU problem - but nothing has shown up on the computer scope at two dealers.

[Later reply from David:] A local mechanic found a small tear in the large diameter air hose (has the bellows) that runs from the air mass sensor (and air filter end) up to the throttle body. He did a quick repair using a sealant. Since then everything has been fine - no more starting problems. It's very easy to inspect this air hose - just undo the clamps at either end - make sure they are tight when you put the hose back on! I spoke to another Volvo dealer recently - regarded as the best in Toronto - and they said that this air hose vibrates - hence the need for the bellows section. In addition the material used to make the hose does start to perish over time and this may lead to some brittleness and tears appearing. When that happens - it can lead to all sorts of problems they claimed. The replacement hose costs just $50 Canadian.

Frequent Stall or Hesitation: Carburetted Engines. [Tip from James] My 1986 740 with B230K (carburetted) suffered from a constant stalling problem, needed to be revved all the time. Following the dealer's advice, I installed a rebuilt carburettor which did not solve the problem. I found that a relay had burnt out

that controls the idle solenoid/cut off valve/intank pump/ IAC. The relay is green and about 2 inches long by about 1 inch deep and one could quite clearly see the burnt-out solder joints when it was opened. I fitted a new one for £32.00 including the diagnosis and this solved the problem.

No Start, Poor Fuel Economy: Timing Problems [Tip from Tom Francis] Poor fuel economy and then a perplexing no start situation was the result of a broken indexing pin (roll pin) in the end of the cam shaft used to keep the cam pulley and the cam shaft in alignment. The broken pin allowed the cam to rotate out of alignment 30-40 deg until the no start condition. Remains of the hardened steel pin in the cam can be drilled out using solid carbide drills bits in successively larger sizes, but not large enough to ream out the hole. High speed steel or carbide tipped drill bits may break off in the hole. The roll pin is most likely a standard M5-80mm size (5mm dia hole, 80mm long), available from a dealer for $0.90 or well supplied hardware store. [Editor] This applies as well to the crank timing gear, which has a similar indexing pin, and is a very good argument for using the correct torque procedures when reinstalling the cam or crank bolts.

Stalls in Heavy Rain: Water Leak in Hood. [Tip] I finally figured out my stalling problems after a heavy downpour (ie, Tropical Storm GASTON and FRANCES) My 940 once again stalled on me about 5 miles away from my house... This is the second time in a row and it was after a heavy downpour, with water leaking onto the distributor cap. After examining the hood weatherstripping, I found that the water was pouring down through the windshield washer nozzle hole in the hood. Sealing this with silicone caulk solved the problem.

Stalls While Car is Cornering. [Symptom] When I take sharp turns regardless of speed, the car will sometimes just cut out and die. [Response] The crank position sensor wire where it enters the crank sensor shell can fail, causing the engine to stall during turns. Due to the length of cable and the movement of the engine it will show signs of wear and eventually break the wire. When you make a turn or stop you are putting just enough strain on the cable to halt the signal and shut down the ignition. To locate the problem, stand at the left or drivers' side front fender and look behind the rear of the cylinder head down towards the bell housing . The crank sensor sits in a hole at the very top of the bell housing. The outer covering of the wires which is approx. 1/4 in./1 cm in diameter usually splits open down in that area. With the engine idling try to move the harness and see if it affects the idle.

Mixture, Misfire or Idle Control Problems

Runs Rich; Black Smoke; Poor Acceleration: ECT, TPS, FI. [Inquiry:] I have a 1985 740t with 244,000 miles and a m47 manual transmission. It has the 230ft engine that is all original including the non-liquid turbo without an overhaul. The car runs rough throughout the rpm range and put out black smoke while doing so. Lots of black smoke. Other times (less and less) it runs like a top, no problem. I replaced the fuel pressure regulator but it did not help. I am getting about 43psi at idle. When it is running in the bad mode the fuel pressure is still 43psi. When I

drive the car I have to accelerate either very easy or in wide open throttle to get the car to go. It is at its worst just as boost comes on. Any Ideas?

[Response 1:] Here's one idea, but it really applies to the non-turbo engine -- so I could be a million miles off base on yours..... The fuel mixture is influenced by the block temperature sensor (Engine Coolant Temperature ECT see Diagnosing ECT Failures). A cold engine requires more fuel, and a warm engine needs less fuel. A cold sensor is a high electrical resistance. An intermittent open condition of the sensor, the connections, or the wiring harness will trick the FI ecu into thinking it's about -60 degrees. It will pump in tons of fuel. On many of the engines -- and again, I'm not positive about yours -- there are two sensors. The sensor for the dash gauge is in the head, about under the intake runner for cylinder #2. The sensor for the FI system is in the head, about under the intake runner for cylinder #3. Tough to get to.

I helped fix a situation (on a '90 740, non-turbo, Rex-Regina system -- yours is Bosch) where the connector had pushed out of the plastic housing but made intermittent contact with the spade connector in the sensor. Some days, it ran great. Other days it flooded so bad it wouldn't always start. Fixing that stupid problem made a world of difference!

[Response 2:] Also..... be sure the throttle switch (Throttle Position Sensor TPS) is working and adjusted, and the AMM is operational.

[Response 3:] Very similar situation in my '86 745T drove me nearly crazy for about 2 months. It was a leaking fuel injector

Symptoms of ECT Failure: [Tips from Isaac Babcock, who disconnected his ECT to find out]

- Difficult cold starting. Approximate crank time 4-5 seconds.
- Extremely difficult hot starting. Cranking 20 seconds may or may not yield a running vehicle.
- Once started, car idles like absolute crap for 5 minutes while the engine burns out all the excess fuel that the computer is blindly dumping in. May die repeatedly during this time. Small amount of black smoke flows from tailpipe.
- During 5 minute crap idle time, car will not tolerate any accelerator input. Depressing accelerator kills the car immediately.
- After the 5 minute extreme fuel enrichment exercise, the car lets out its last puffs of black smoke and you can drive off.
- Idle once engine has 'stabilized' is a fairly steady extremely high idle. It will be quite noticeably higher than normal (over 2,000 revs). I thought my computer had fried the IAC motor circuit with it stuck full open. Turning the idle bypass screw all the way closed can only bring the idle down to 1250rpm.
- Smell of unburned fuel floats around car at all times. Gas mileage is atrocious under all conditions. I achieved 16-17mpg on my last tank.
- Power is fairly crappy, though not much worse than usual.

760T Floods and Stalls: ECT?. [Inquiry:] I have a 1986 volvo 760 turbo with 207,000 miles on it. I recently purchased and at the time it was running on three cylinders and had sat for about six months. I replaced the flux amplifier and it ran

on all cylinders. The man who sold it to me also told me that he had an intermittent problem... It would stall out occasionally. He was true to his word...If it is cold (running about 15 min.) and you give it too much gas it starts to flood out. If you floor it while it is flooding out it starts to catch on the other cylinders and eventually will go. If you stop the car while it is flooding out it will either stall or run on 1 or 2 cylinders. One time I disconnected the map sensor while it was flooding out and it started to idle normally. While driving behind the Volvo it spits black smoke when it is flooding and sometimes even when it isn't acting up a little bit of black smoke will come out of the exhaust. The problem clears up if you drive about 30 miles on the highway at constant speed. After that you can stop it idles pretty good.... misfires a tiny bit.... and you can take off like a bat out of hell...also about a week ago I tried to start the car and it would only run on 1 cylinder, then not at all. I pulled the plugs and they were all fouled I put in new plugs and it fired right up. I tested to make sure every cylinder was firing and they were...is it my computer??

[Response: Don Foster] I'd consider looking at the temperature sensor or connections to it. There are two sensors -- one for the temp gauge, one for the FI ecu. The gauge sensor is a one-wire device, the FI temp sensor is a two-wire device. The FI temp sensor is mounted in the head, under the intake manifold, approximately under runner #3. It's not impossible to get to -- just almost. (The gauge sensor is under runner #2 -- ignore it.)

The sensor is an NTC thermistor -- that's negative temperature coefficient, or as the temperature drops, the resistance rises. If the sensor fails or if you have a bad, broken, or corroded connection at the sensor (or anywhere in the harness going to it) the FI ecu measures high or infinite resistance. The ecu thinks it's about -100 degrees, and sends tons more fuel to the engine. See Symptoms. And if it's an intermittent problem, your engine can be running fine and then go into gas overload 5 seconds later. And vice-versa. I helped fix a problem in a '90 non-turbo with terrible intermittent flooding. We found one connector in the sensor plug had loosened so when the plug was pushed onto the sensor, the connector got pushed back up the plastic housing and sorta dangled freely -- one second it touched, the next it didn't. It took hours to zero in on this tiny failing. See more at Diagnosing ECT Failures

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Cold Start, Dies; Dirty or Faulty IAC. [Symptoms:] Cold Start: Car starts immediately with no throttle application, idles smoothly for about one second, then hesitates and dies. Ditto for my 1990 245DL.
Starts up cold for one second, then dies.
Sometimes, all cranking I wish to do will not
restart it. If I sit and wait about 5 minutes, it
will start and run l

[Suggestions:] Check the IAC (idle air control-
This provides for more air, or faster idle on start
up. The fact that it starts readily when cold
indicates the cold start injector is working
properly. See hints below.

[Symptom:] **Poor idle**. [Diagnosis:] Clean the

dirty Idle Air Control Valve (IAC). I should have remembered. The car did not start at ALL. So, I took out, removed the two hoses and cleaned it by spraying it with engine grease remover. It had a lot of dirt in it. The Idle Air Control Valve is located under the intake manifold; below the second cylinder. It is about 3 inches long and about 1.5 inches in diameter (I do not have one next to me so these dimensions are from my memory.) It has two rubber hoses connected to it through a T connection. It also has a snap-on electrical plug. This is most likely your problem. Here is how I clean it:

- Remove all hoses and electrical connector, then remove the IAC
- Open the rotating valve to expose the innards. Spray some carburettor or fuel injector cleaner into the opening and shake it around. Make sure you plug the other end with your palm to trap the liquid inside the IAC.
- Open and close the flapper valve with a small screw driver to loosen any dirt, etc. contained inside. Don't scratch the valve
- Turn the IAC upside down to empty out the dirt and fluid.
- Repeat step 3 through 5 about 8 times.
- Test the IAC on the car without permanently installing it. You might have to repositioned some hosing to accomplish this task.

If you still have problems, then either your IAC is dead and must be replaced or the problem is somewhere else. [Editor's Note: See the IAC rebuilding procedure noted below.] [Ian Giles] By the way, when installing the IAC the arrow points in the direction of airflow through the valve, so it points towards the intake manifold.

Poor/Surging Idle: Idle Speed Control Motor. [Tip from Anonymous Source] I have a 1987 model 780 with about 115K miles. Just wanted to share my experiences

About 10% of the time my Idle would start to surge between 200 and 1200 rpm while sitting at a light with the foot on the brake. This up and down action would load up the engine with fuel and it would start emitting black smoke. It seemed to be somewhat related to engine temperature. Occasionally it would get bad enough to kill the engine, but at highway speeds it seemed to run fine. I first looked at the idle speed motor, but it appeared to be functioning properly when the voltage was applied to the terminals per the normal checks. I then performed the disassembly and cleaning of the idle speed motor as described in this web site. Even though the inside of the motor was reasonable clean, I went ahead and polished the

commutator. I detected that the bearings that the rotor turns on were a bit gummy so I cleaned it well and lubricated it with a bit of graphite. Ever since this little operation it has been idling like a champ. I suspect that small bits of commutator crud and wear on the brushes may have been creating dead spots and poor response to idle demands form the processor.

Low Idle or Stall in Regina-Equipped Car: Coil Pack.
Low Idle. [Jason R.] If the Regina-equipped car has a low idle that can not be corrected by any normal means, replace the Coil Pack with a new coil. You can get theses from RockAuto for about $30.00.

Stalling. [Arthur Aldrich] My 1992 745 with Rex/Regina had developed a habit of intermittent stalling upon acceleration. 192,000 miles. Sometimes it would die in the middle of the highway, or worse yet, at a railroad crossing. It would always restart. Replaced rpm sensor, injector ballast, checked idle air control...this went on for two years. I bought a used coil pack on Ebay and swapped it out. Problem disappeared. Car now starts every time. Amazing acceleration and better mpg. Moral of this tale: The coil pack, and its very long lead to the distributor, could be the cause of intermittent and otherwise inexplicable problems that masquerade as other expensive issues such as fuel pump or ecu modules

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Intermittent Stalling: Faulty IAC or Hall Sensor. [Symptom:] Intermittent stalling/no start condition on an 86 740 (b230F) manual trans: occasionally dying (engine suddenly has absolutely no power, but the dash lights do not come on) while driving on the expressway and around town. After pulling over to the side, the car invariably will restart and seem to run fine. No rough idle or other problems were noted.

[Fixes Attempted:] Several months back (per list advice), I replaced the fuel relay, which up until the last week seems to have cured the problem. Over the last couple of days, the car has started acting up again in the same manner. Now, the car also, when it does restart, sputters and runs extremely poor for awhile, then goes back to normal. Also, in the driveway, I was able to get the car to reliably stall when he put on the brakes. I replaced the idle speed motor, which seems to have affected the brake-induced stalling (plus the car idles much better), but not the intermittent stalling. He also noticed a bare temp-sending wire, which he cleaned and re-taped (but we don't suspect that has to do with this failure.) Per past list advice, I've suggested

- examining all vacuum lines
- rechecking fuel-pump relay and socket for cold-solder joint/overheating socket
- in-tank pump and screen
- the power stage connectors for corrosion
- radio suppression relay
- general condition of wiring harness (the car lives in the very heavily salted road conditions of northern Ohio)

[Diagnostics and Suggested Fixes:] Below you'll find several procedures [Composite from Steve McChesney and others]. Hope they will help.

Fix 1: Clean the Idle Air Control ("IAC") Valve. See above for procedure.

Fix 2: Rebuild Idle Air Control Valve: Save $150 by fixing IAC instead of replacing it.(**Note: the IAC on newer LH 2.4 cannot be dissassembled but it can be cleaned** Also note that Regina and Bosch IACs are NOT interchangeable if you are considering a replacement.

- No fast idle at start up.
- Grounding CIS (test point) does not have any effect on idle. (grounding the test point should disable air control valve (IAC)
- OR: The idle ('87 745ti) shoots up to about 2500 RPM. No amount of cooling off, throttle blipping, or general search for vacuum leaks would bring it down. I checked all the hoses, fuel pressure, mass air sensor, and coolant temp sensor. Everything was fine. And the car ran fine too, just a high idle.

This is a common problem on cars that use this Bosch system, including Volvos and BMWs. It's especially bad on turbo cars, and cars that use crankcase air for idle makeup because of the oil that comes along with the air.

Solution: clean the slip ring inside the IAC The IAC is a metal can beneath the intake manifold, with two 1" hoses that feed extra intake air around the throttle body to control idle RPM, and reacts to loads like A/C or heavy electrical (alternator) loads. The valve has three pins, the center is a constant 12V supply, and the outside pins are pulsed by the ECM to ground, to either open or close a circular shutter -- looks something like a revolving door. (Except mind would only open, and close halfway.)

- **Electrical Diagnostics:**
- Start the engine.
- Disconnect quick connector at air control valve.
- Test for battery voltage on the middle pin (it is pin number 2 GREEN wire if you slide the rubber off), you should detect 12V or so (with engine running).
- Turn off the engine.
- Test for ohms on IAC between middle pin and any side ones, you should have between 6 and 20 ohms in each case depending on the model. If you do have this resistance, then it means that the motor of the IAC is good. If not, don't give up yet.
- Disconnect the hoses from the manifold and the intake hose, disconnect the 3-pin electrical connector, loosen the top nut on the band clamp around the valve body, then remove the valve. Off the car, look down the bore of the valve, and then by supplying the center pin with 12V and shorting either of the outside pins to ground, the door should fully open or fully close.
- **Disassembling and Cleaning the Valve**
- Clean the slip ring (the one wherein the brushes are touching) inside the IAC by taking the IAC apart. [Editor's note: this is not possible on newer IACs with no housing clips.)
- Before you take it apart, mark the housing (a pen mark or screwdriver will do) so you can assemble it in the same position. IT IS IMPORTANT!
- With a small screwdriver pry up the clips or crimps which are holding the housing (there are four of them). Once they are up, pry on the housing a bit and the whole thing should come out. At this point, you will encounter a bit of resistance because of the strong magnet inside, but there is nothing to worry

about, just keep going until everything comes out. Be careful not to lose the o-ring or the small cone piece -- which will probably fall off the armature shaft and be laying at the bottom of the barrel with the permanent magnets and the wiper contacts. You MUST NOT try to push it in once you started separating the housing (or you will destroy the brushes inside the valve). Once you open it, you will understand why.

- You will then see oil and crud all over the armature and the commutator. Clean it up with brake cleaner and carefully flush away all crud especially from gaps in commutator.
- Clean the contact points with very fine emery cloth or a Scotchbrite pad and polish them. Be careful; don't bend anything. Again, make sure you don't lose the little cone piece. You'll need to get it out of the barrel for re-assembly - it will come out easily but you have to use something non-metallic because of the strong magnets around the housing.
- When everything is spotless and oil free, put the cone on the end of the armature shaft, so that it tapers away from the armature. The cone is important, because it acts as a ramp when you replace the armature, gradually spreading the wipers so they land on the commutator without bending them out of contact. Also, a little silicone grease on the o-ring seal can't hurt. Once you take it out, slide it over the shaft and keep it in the upward position (so it won't fall off) while assembling it.
- To re-assemble, put the tee upside-down on the workbench, with the cone in place, and gradually feed the barrel down. It's a bit of a trick to keep it straight, because the permanent magnets have a habit of sucking the armature from side-to-side. It doesn't take much force. Once the armature is seated properly, re-align the marks on the barrel and tee by simply twisting the tee relative to the barrel. If you forget this step, the valve may likely not open or close fully. After doing so, then you are done. Push back the clips (if you have clips, and don't use a hammer
- Re-test the valve as above with test leads before the final crimping. Mine worked fine now, fully open, fully closed. I then squeezed the crimp tabs back into place with large channelock-type pliers, and double-checked the alignment marks. Replace the valve, making sure the flow arrow on the tee points in the proper direction. The arrow should point TO the intake, FROM the main throttle inlet hose. Tighten the hose clamps, and viola! New IAC valve. The entire procedure, including the pulling of the valve out and installing it back takes about 30--45 minutes. Test the side pins for ohms and re-install the IAC. You should now have a fast idle. Oh, make sure your PRM at idle is about 800 rpm. PS: I drilled and put in a small screw to prevent housing from rotating.

[Another Tale of IAC Repair:] The following Idle Air Control Valve repair might be of interest to fellow tightwads who experience a HIGH idle problem. I removed the bad IAC. The valve was not frozen, but moved quite easily back and forth. That's when I decided to open it up and look inside. Opening involved prying open several tabs around the unit's waist. Out came the solenoid innards which looks like the armature of a small motor with enamel wire winding around three arms. The cap removed from the valve contains a magnetic lining along the wall and three brush contacts near the top. The top of the armature where the brushes should contact was VERY greasy. I cleaned that and the contact brushes inside the IAC cap. A multimeter confirmed that there was continuity among all three arms of the

armature: ohms1to2=21, ohms2to3=21, ohms1to3=42. So apart from the grease, I could see no problems. Therefore, I put the armature back in the IAC cap. This required some trial and error because the armature keeps wanting to stick to the magnetic sides of the cap. Once back together, I bent the holding tabs back in place (keeping pressure between the two parts).

The first time I started the car after installing the cleaned IAC, the idle was still high. However, I removed the IAC again, wiggled the valve back and forth a few times, and reinstalled the IAC. I checked the resistances at the electrical connection pins and this checked out. Maybe the contact brushes hadn't quite seated themselves yet. The second start resulted in a nice idle control. In PARK, the car idled 600-700 RPM when warm as opposed to about 1600 RPM when the IAC didn't work. I've been driving with this cleaned IAC for several days now. The idle system is working fine. And I hope it stays that way! Was all this trouble worth it? Well for a tightwad, I'd have to say yes (since the IAC was successfully repaired).

[Fix 2:Check Hall Sensor] Below is the procedure to check Hall Sensor (inside distributor) for B230F/FT ignition systems: EZ-117K, EZ-118K on pre-89 cars.

- Disconnect WHITE/RED AND BLUE leads from ignition coil (to prevent arcing damage).
- Undo the distributor connector
- When the ignition is ON the Voltage between positive terminal (red lead -Nr. 3) and ground should be approx. 11V. Voltage between (blue lead - Nr.2; middle one) and ground should be 5V. Resistance between (black lead - Nr. 1) and ground should be 0 Ohms-
- Undo connector from the control unit (above the brake pedal) and remove the sealing washers (plastic inserts on the side of the connector). Replace connector without cover or sealing washers.
- Disconnect white/red and blue leads from ignition coil.
- Measure voltage between terminal 24 at rear of connector (blue lead) and ground. NOTE: Connector must be attached to control unit.
- Switch on ignition. Turn crankshaft by hand. Voltage should indicate OVER 1.8V each time a vane passes Hall generator. Instrument should read approx. 0 (0 - 0.7V) each time an opening passes Hall generator. Correct voltage: Less then 0.7V or more than 1.8V.

Hesitation on Acceleration; Several Diagnostic Checks. [Symptom:] Hesitation on acceleration, bogging.

[Diagnosis 1:] Check the health of the knock sensor. It is an inexpensive part that listens to the engine, senses knock and automatically retards the timing. They get full of crud etc. and give false information. Incorrectly retarded timing will give you a noticeable hesitation.

[Diagnosis 2:] A slightly faulty AMM, i.e. during low air mass conditions, can output a too low air mass signal to the ECU causing a too narrow (lean) basic injector ON pulse width. Carefully check the AMM's wiring harness plug. Slight misalignment of the female contacts can cause ECU input problems.

[Diagnosis 3:] Clean throttle body.

[Diagnosis 4:] Is your temperature gauge correct? Is the engine heating up properly? I had the exact same problem and it was finally cured several weeks ago after the dealer replaced the thermostat that controls the temperature gauge. Now the engine is a lot more smoother and the car has regained some of it's power!

[Diagnosis 5:] The fuel pressure regulator is worth a careful inspection. The fuel pressure must rise instantly in response to the vacuum signal fall that accompanies a throttle opening. A hardened diaphragm might be causing the fuel pressure that has been lessened by the fuel pressure regulator to not increase as rapidly as it must and you won't get the appropriate fuel quantity in spite of lengthened injector duration. Try an acceleration test with the vacuum hose pulled off fuel pressure regulator. Easiest way to check the FPR is to pull the vacuum hose off of it while the engine is idling. If the idle picks up, your FPR is good.

[Diagnosis 6:] Oxygen Sensor malfunction. If the engine bogs and will not rev, with a very slight hint of backfire/misfire, while accelerating from a dead stop; or cracks, once in a while, like it is backfiring through the intake, then check the oxygen sensor. Several correspondents have reported sensor overvoltage (a peak output of 1.3V instead of the normal 0.9) from generic sensors (Bosch, NGK) even if relatively new. Replacing the sensor solved the problem.

Hesitation: Poor Driveability: Bad Air Mass Meter Symptoms.
Limp-Home Mode:

[Would someone give me give me a description of what a bad AMM feels like?] My single experience with a bad AMM was that the engine would barely run at all and was not driveable. I think it reverts to limp home mode if you pull the connector off. But I still think you should clean the throttle body. Since the purpose of an AMM is to regulate air flow to the throttle body, it usually sits right on top of the air cleaner or close by and there is some sort of connector on it. Remove the connector and see how your engine runs. It should run like crap, i.e. no power, idle fluctuates wildly, or engine stalls. If this is similar to the problems you're experiencing now, chances are that the AMM is bad. Another thing to check is that there aren't any air leaks between your AMM and the throttle body.

[More Symptoms] When I depress the gas, the car hesitates severely, backfires a few times and if I keep pressing the gas, will stall. If I back off the gas I can usually accelerate very slowly and once I get up to speed it is ok. When this is happening the idle goes up to 1300 instead of the normal 750. I get codes 1-2-1 (Faulty signal to/from Air Mass Meter), 3-2-2 (Air Mass Meter wire burn-off signal absent or faulty) and 2-3-1 (Fuel trim (lambda control) too lean or too rich at part load). Pulling fuse 1 for fifteen minutes to reset the ECU would solve the problem temporarily. The solution was to replace the AMM.

Connector Problems:
More than one inexperienced technician has failed to cure an intermittent driveability problem by replacing the mass airflow sensor. Even if your pinpoint tests suggest a failing sensor, always inspect the sensor's harness connector for

loose terminals first. Be sure all the terminals are locked securely inside the connector before you condemn the mass airflow sensor. Some routinely remove a harness connector and then reinstall it to see if reseating the connector solves the car's problem. But reseating the connector on this Bosch airflow sensor may complicate diagnosis by pushing the loose terminal outward. So, your quick-fix trick actually makes the car run worse than before! Also, try cleaning and de-oxidizing the connector before reinstalling it.

Disintegrating Air Box Foam:
[Tip from Chris de Courcy-Bower] Check the air mass detector. This can be defeated or even damaged by bits of disintegrating foam rubber that break away from the upper casing of the air filter box. As the foam rubber seems to serve no purpose, it is my recommendation that owners remove every trace of it before it causes a failure.

Backfire, Poor Acceleration: Failing Radio Suppression Relay.[Tom Rolyak] I've had two radio suppression relay failures. Both times Both times I noticed abnormal backfiring when decelerating. Much more pronounced than when a throttle switch sometimes sticks. Also the idle speed would drop down to about 500 rpm's and then return to normal. It also seemed a little balky on acceleration. I swapped the relay and the problem was solved. I pulled the old relay apart and using a microscope could see cracks in the solder.

Hot/Cold Air Box Thermostat and AMM Failure. Unless you live in a very cold climate I don't recommend replacing the cold/hot intake air valve and plumbing. The valve has a tendency to fail in the hot air position thus supplying your intake system with pre heated air and having a tendency to fry your air mass meter. In addition, it can cause mid-range knocking if it fails. Check out the Turbobricks net page (http://www.turbobricks.org/). There are instructions there on doing an air box mod that recommends and explains how to do away with the hot/cold air valve and plumbing and redirect the incoming air to the air box. You can, though, just change just the thermostat itself. While Volvo will only sell you the complete air duct w/ thermostat, you can buy an aftermarket thermostat for any 740/940 from fcpgroton and install it yourself.

Operation of a functioning thermostat: The air flap is closed at +5C (41F), +10C (50F) half open, +15C (59F) only cold air.
[Editor's Note: See Air Box Thermostat Change for more information about changing the thermostat in 7xx/9xx cars.

Misfire and Broken Distributor Wires.

Symptoms: Misfire is very pronounced under heavy throttle -- think of a mechanical bull -- which leads me to suspect something in boost control. But the tach also shows about 150 RPM variation at idle, which hints that the misfire exists under no load conditions.] I had this happen to my 85 as well. It turned out to be the connector for the distributor wires under the dist. cap. had broken, and the wire insulation had disintegrated. The wires were grounding out on the distributor housing. For a while it would run fine, then it would miss like you say. I went

around the barn on this and spent significant time on things that made minimal difference. I don't know if I broke the connector off or not, but the wires had fallen to the insulation eaters that befall Volvos of that era. I ended up putting in a new distributor because it was convenient and the car had completely died. I did find out that a new hall effect pickup can be installed by drilling out the rivets on the old one and screwing on a new one. To check, put your hand under the bottom of the distributor and see if there is significant wiggle in the connector there. The cap should hold it tight, but on mine, once I was told where to look, it was obvious what the problem was.

Failing Distributor Shaft. [Andrew Smith] After noticing misfire and stumbling in my 110k 760, I discovered my distributor had mechanically failed: the shaft was worn and allowed the rotor to wobble and miss contacts. A new distributor solved the problem.

Misfire Under Load: Ignition Power Stage. [Dick Riess] 1987 B230F has had a miss or hesitation under load for ages and I have replaced or traded just about every possible item. This has been one of the most tough to diagnose problems I have encountered. Purchased a new power stage and plugged it in (aftermarket) and this seems to have cured the problem. [Tip from Matt] In my 740, this was accompanied by idle problems, misfiring, and a fluctuating tachometer needle. Solved with a new power stage unit.

Stumble, Stall, Poor MPG: Bad Engine Ground Connection. [Tip from David Hungerford] What appeared as fuel supply symptoms were not relieved by replacing the filter, FPR, or both pumps (or by checking lines with vacuum pump/gauge). The problem turned out to be a (very) loose FI ground connection. When reaching around blindly to loosen the distributor mounting bolts (checking Hall's sensor connections), my eyes happened to be looking at the intake when my arm brushed the ground strap running from the intake to the firewall--the wires moved at the fuel rail mounting bolt, which also serves as the main round connection for the injectors. It was loose enough that the wires bounced around with engine vibrations. I just tightened it and all stumbling/stalling/AND poor mpg went away. The main lesson here is to NOT skip over the first instruction in all troubleshooting guides: First, check all connections for tightness and evidence of corrosion. See also the section on maintaining engine and chassis grounds.

Symptoms Related to Engine Sensors or ECU:

Engine Failure/No Start/Severe Stumbling: Bad ECU See the FAQ file for much more information.

Common symptoms of a failing LH injection computer

- Engine will not run at idle
- Air-fuel mixture is too rich (this can damage catalytic converters)
- No fuel pump operation, butthefuel pump operates when its relay is jumpered between pins 30 and 87/2

- The engine will not rev higher than 3000 RPM
- Engine will not start, spark plugs are dry and the ignition system produces spark.

Intermittent stalling in 89 760T. The owner of the shop hinted that late 80s and early 90s 760s have had problems with their computer chips Has anyone heard of this?

[Response 1:] Yes, very much so...LH 2.4 modules from 1989-1991, maybe 1992 too, have been very troublesome. However, as far as I know, 1989 Turbos still used LH2.2 modules, so I'm not sure that this applies to your car. Also, often when the modules fail, they fail rather radically, such as the car running very rich, or a no-start or cases like that.

[Response 2:] I experienced almost identical symptoms for several years. They went away when the ECU on my 760 Turbo had to be replaced because the AC enrichment circuit went south.

Marginal Operation. When mine died it got stuck in diagnostic mode 3, pulsing the injectors every second, which was enough fuel to start the car but not much more. Other cases I've heard of has the adaptive rich code getting set permanently.

[Yet Another Opinion:] As a general rule, ECU's don't go half bad, and don't work intermittently: they work fine or they don't work at all. It is wires and connectors that have off days.

[JKordzi]The 561 ECUs have had very high failure rates. Used 951 ECUs (the replacement model) are pretty reasonable now and may be had on EBay or in wreckers' yards for US$50 or so. [Editor] In my case, my 556 ECU vintage 1990 failed in such a way that the car would idle, but any application of throttle to raise rpms above about 1,000 would suddenly cause total injector failure: they would just stop pulsing until the rpms dropped. Changing the ECU solved it.

Engine Lacks Power When Hot: Bad Regina/Rex ECU. [Barry Wilson] Symptoms: 1990 740GL Non-turbo, Rex Regina. Car runs fine when cool. Once engine temp comes up, car bogs down, does not cut out, just loses almost all power. If you keep pushing it, it will pop occssionally out of the exhaust. Idles normal. No trouble codes. Plugs look normal. Sensors appear normal: air temp, manifold pressure, knock. After extensive testing, the problem was the REX engine ignition computer. While one other case of this was reported due to a bad ground near the PS pump, that was not the case here. Replacing the computer solved the problem.

Hesitation, Poor Idle: ECU Failure with Codes 2-3-1; 2-3-2. [Tip from Al Nettleton] Symptoms:

1. Error codes 2-3-2 & 2-3-1 (Mixture too lean or rich)
2. O2 sensor replaced with no success
3. If the error codes were read & cleared, they come back almost immediately

4. If the ECU is unplugged (or the battery disconnected), the codes clear but come back after about 150 miles. For the first 50, or so, of these, idle is rough, next 50 - hesitation from a standing stop, the last 50 - runs well. BUT . . .
5. Running lean.

Successful repair required replacing the air mass meter (AMM), intake bellows between AMM and throttle body, and ECU. Parts swapping confirmed the need for all three. One important finding - the air bellows can leak at the end connections, even though there are no cracks or holes in the bellows and the clamps are tight. Apparently they get to be so inflexible that a good seal is not possible. We should now be ready for another 100K.

Loss of Power; Rough Running; Knocking: Bad Engine Knock Sensor. A failed knock sensor may be felt as a general weakness throughout the powerband and a different tone to the motor. When no knock sensor signal is detected the EZK ignition system defaults to full spark retard. This can also result in the motor running a little on the rich side, as a kind of side-effect (More ignition advance usually = leaner burn, more NOx emissions; less advance usually = richer burn, more HC and CO emissions.) See Engine Sensors for more information.

Symptoms. Higher idle, no power; running rough at RPM higher than idle. It jerks every few seconds and there is no pattern to it. It idles and starts fine.

[Rafael Riverol] Other symptoms include hesitation, poor throttle response, lack of acceleration, especially when cold.

[Marc] The car starts fine and will run for 2 miles and then lose power. It never stalls just won't move. If I shut it off and immediately restart it, it will run fine again for another 2 miles and so on and so on. When it runs fine, with a timing light hooked up on acceleration the timing will retard 1 or 2 degrees before it advances. If I check it when the problem is occuring it will retard 6 or 8 degrees before it tries to advance. Solution: new knock sensor.

Diagnosis. Check the knock sensor, it senses knock (no kidding) and retards the timing. When this gets faulty, it will make the engine have very poor power, lousy and jerky acceleration, but will start and idle fine. It's a small black plastic covered unit bolted to the block (ten mil. bolt) under the intake man. with a plug attached to it. One minute to remove. It listens to the engine. Mine had a cracked plastic cover and was covered in oil. I put a used one in (new they're ~$40) and it's like I suddenly had a new car.

Mid-Range Engine Knock. Anecdotal evidence notes that if you experience mid-range engine knock when the engine is warm, inspect the airbox thermostat for proper operation. If it sticks in the "warm" position, it allows preheated air into the intake system. This will also, over time, ruin your air mass meter.

Retarded Timing or Knock Sensor Code: Wiring Interference. [Tip from Charles Dinges] If you have unexplained timing retardation (poor acceleration) or an unexplained knock sensor error code, try re-routing the knock sensor feed

wiring away from the alternator. Anecdotal reports of electromagnetic interference seem to implicate the alternator in this problem.

Rough Running; Cylinder Diagnosis [Inquiry: 1992 740/ B230F] The car is hard to start and when it does, it idles badly (everything shakes like it's running on 3 cylinders). Once the engine warms up, it runs smoothly and the problem disappears.

[Response: Chris Mullet] When it's running rough try to identify a particular cylinder that might be the problem by pulling spark plug wires one at a time until you find one that has little negative effect when removed. If you find a bad cylinder, make certain the intake manifold is properly torqued. While it's running rough, squirt something like light oil around the intake gasket in the area of the bad cylinder. If it smooths the idle temporarily, you found the problem. If not, try swapping injectors between two cylinders and see if the problem follows it. If not, try swapping injector wires. (You could do this on the older models, as injector timing wasn't particularly critical, so I assume you can do it on the newer ones.)

Hunting Idle; Faulty TPS or ECT. [Symptom:] In the last 2-3 weeks the engine idle speed can vary wildly or act normally. Specifically, sometimes upon first start the RPM's will hold at close to 2000. Then upon warming (3-5 min) the idle speed will swing instantaneously from near die out to about 1600 RPM's. This wild swing occurs only when in park or neutral and never shuts completely down. The RPM's will stabilize when in gear (auto trans) and holds at about 1000 RPM's and will hold at about 1600 RPM's when taken out of gear. The symptom is intermittent. When the engine is acting normal the idle in park is about 1000 RPM and in gear about 750 RPM. I cleaned the throttle body (for the third time since owning the car) about a week before the first time the unusual symptoms occurred. I have disconnected the AMM wiring during an episode and the engine speed changed but I still am not sure if I know what to look for there.

[Diagnosis:] What you describe could be the FI computer trying to limit the rpms at idle so it doesn't over rev. The control loop is rather crude and is there only to save the engine from self destroying. Something is telling the computer to rev up and it does and then cuts off things at 2000 rpm. The most obvious guess would be that the throttle position sensor (TPS) is mis-adjusted or broken. Make sure that it clicks just before the throttle plate closes. Also, you may want to check that the FI-unit actually sees this click by looking at pin 2 of the FI unit. It should be 0 Volts at idle and battery voltage when the gas pedal is depressed a bit. You say you cleaned the throttle body BEFORE the symptoms started appearing, so perhaps there's a chance you accidentally didn't adjust the TPS position properly?

The other thing to check is the engine coolant temp sensor (ECT). Look at pin 13 of the FI unit. When the engine is warm you should see 350mV. See Diagnosing ECT Failures for more information. In addition, since you've disconnected the mass airflow sensor (MAF), the computer may have gone into limp-home mode permanently which will cloud the diagnostics, so you should really check and reset any error codes stored in the system before you do anything else. However, unless the Check Engine light has come on the MAF disconnect didn't trigger any code setting.

High Idle at Startup: TPS Failure. Symptom: the idle surges immediately to 2000-2500 rpm after a cold start, then gradually declines to 950-1000 rpm as the engine warms up. The idle rate seems dependent on temperature: lower temperatures cause a higher idle. Diagnosis: TPS failure The TPS internal microswitch does not sense the idle condition, even though a click might be heard at the switch. As a result, the ECU does not control idle through the IAC valve and idle is too high. See Throttle Position Switch for information on diagnosis, adjustment or replacement.

Idle Surge, High Idle, Poor Idle: Vacuum Leak [Inquiry:] Idle surges at times between 1200-1600 RPM when car not under load. Idle Control Motor? Other?

[Response: WBain] You have a vacuum leak. Check all lines especially at the throttle body. Also if it's a turbo, look for a bad intake manifold gasket.

Intake Manifold Gasket Leak. Mine has had a very rough idle. I checked the FAQ and cleaned the throttle body and checked for leaks in the hoses. I was finally able to isolate a leak in the intake manifold gasket. The propane test didn't find the leak. The only way I was able to isolate the leak was with the mechanic's stethoscope with the probe removed and only using the tubing to get very close to the gasket and follow the contour of the manifold. Replaced the gasket (approx. 2 hours) and the car runs fine.

[Tip from Gary Goms] Vacuum leaks can be easily diagnosed by several methods. I believe the safest and easiest method is to use a modified mechanical stethoscope to listen for vacuum leaks throughout the system. To modify the stethoscope for locating vacuum leaks, replace the probe with a length of plastic hose or fuel line. Alternate methods include listening for a change in engine speed while spraying propane or aerosol carb cleaner around manifold and vacuum connections. The various brands of smoke machines are also very handy diagnostic aids to use when attempting to locate vacuum leaks at the manifold-to-cylinder head gasket, throttle body shaft, throttle body-to-manifold gasket and vacuum hoses.

Slight Backfiring While Coasting; TPS Mis-adjusted. [Inquiry:] The car is a 945T and, after fully warmed up 30-45 minutes on the highway), makes a pupp pupp pupp sound when on the highway and backing off the accelerator. The sound seems to be emanating inside a tin can and is not loud at all. If I had to guess, I would say that unburned fuel/air mixture is getting into the exhaust system.

[Response: Abe Crombie] The injectors should go off on coast. This is controlled by the fuel control unit being able to see closed throttle via the throttle switch. If that isn't adjusted properly or has a faulty internal switch then the injectors may not be off on coast and you may very well be hearing a weak backfire in exhaust. See Throttle Position Switch.

[Dave Stevens] My 740 had a hunting and lurching symptom when coasting at low throttle. The remedy: Check that the throttle cable has not stretched - if it has, the throttle microswitch will be opening the fuel solenoid too late and the engine will be starved at low revs, but will recover fine when accelerating or running on an open

throttle. All that is required is to adjust the microswitch setting by the two screws that fix it in place. With the throttle closed and the engine switched off, reposition the switch slightly so that it clicks as soon as the throttle cable moves. Make sure you don't move it so much that it doesn't click off again when the throttle is released, or the engine may overrun when the ignition is switched off.

Symptoms Related to Electrical Malfunctions:

Sudden Cut-Out While Driving; Electrical Causes.[Symptom:] On occasion, it will just completely cut out on me going down the road. No sputtering, just dead. Usually it starts back up on its own recognizance as I coast for 50 yards or so. Sometimes it does not, but if I pull off and let it cool down for 5 minutes, it starts right back up, and does not cut out again for a couple weeks or so.

[Opinions:]

Since this car has an EFI system, LH-Jetronic I suppose, you could be getting an intermittent electrical fault in that system that'd cause similar symptoms... or I might be totally wrong. First thing, I'd install a tach. If the tach drops to zero as the engine cuts out, then it IS the ignition. But I'd clean all the EFI grounds, the underhood fuse and fuel pump fuses, fuel pump connections, and such before proceeding.

I would check the electrical connections to the fuel pump. Especially the grounding, maybe it is not so much getting too hot that causes the engine to quit, but an intermittent ground. Once you pull over, the broken wire or whatever falls back into place. I once broke the ground wire to my alternator and that caused the engine to quit, though it did sputter a little. The wire was broken in the middle and once I pulled over and the car was still, I had good ground, but once moving, it would make intermittent contact.

Have you checked the fuel pump relay? Similar symptom to yours and seems to be a fairly common problem among Bricksters. A bad/weak coil in my experience shows up as consistent poor performance under high spark load conditions, such as starting and large throttle openings at low RPMs. I check the coil by removing the coil wire at the distributor and firmly locating (not holding unless with insulated pliers) the the wire's tip about 3/8 inch from a block or frame ground point. The spark should be a thick blueish white and easily jump the 3/8" air gap with the engine being cranked by the starter. A weak spark tends to be thin pinkish and sensitive to proximity to ground. The normal arcing voltage (engine running) is in the 12-15 KV range for my '82 B21F LH1.

I have had the similar problem on a 84 GL and found that the ignition pick-up coil in the distributor was faulty. When the pick-up got warm the resistance in the wire showed an open circuit and when it cooled off it was normal again. I replaced the pick-up and problem was solved. I had such a condition on an '83 245 twice once it turned out to be fraying wiring harness right between the rear of the engine and the firewall and once it turned out to be the computer on the inside of the right front fender.

See the FAQ section on Grounds for information about engine and chassis ground

maintenance. See the FAQ section on corroded or loose battery cables for more tips.

Engine Cuts Out at Speed: Ignition Power Stage Failure.

[Inquiry:] My 1990 740 GL Wagon (186,000 miles) stalls intermittently with the tachometer immediately dropping to zero. It does it while cruising on the highway or while idling. I'm able to restart it sometimes with the clutch if I'm moving along, otherwise with the key after I get to the side of the road. If it sits for a few minutes that seems to help in restarting. It appears that all other electrical components are not affected when this happens (radio works, blower, flashers, etc.). It now happens almost daily, but started months ago happening 1-2 times a month, then 1-2 times a week, etc. It's getting worse. My mechanic has replaced some likely components: FP relay (behind fuse box), radio relay (on the coolant reservoir) and crank sensor (with the white band - I had replaced this at 90K as well). I also had a cracked distributor cap that was replaced. Plug wires are in good shape.

[Another similar case:] My symptoms were, the tach dropping to zero and then the engine would bump start at speed and at a stop the car would shudder and then die unless the motor is revved up at a stop to bump start the car.

[Response: Lincoln] I would check your power stage, it amplifies the signal from the computer to the coil. I had the same thing happen to me two months ago. I think another person had it happen to them too. I think I paid $90 for the part and $100 for them to find the problem. The part is located to the right of the battery on the fender.

[Response 2: Fred Guest] In our case it is caused by a bad connection at a plug connecting the power stage mounted on the left inner fender. We unplug the connector, clean the spade terminals with emery cloth and squeeze the female connectors with needlenose pliers if we have them with us, then put it back together and it is fine for a while.

[Editor's Note: use electronic connection de-oxidizer instead] I believe the round things on the fender have something to do with the fuel injection. Since your tach goes to zero I expect you have a similar corroded connector problem - but probably in the ignition system rather than in the fuel injection.

Note: faulty engine and chassis grounds can play havoc with the electrical system and cause component failure. See the FAQ section for more information about diagnosing, curing and preventing ground troubles.

Poor Power; Poor Engine Response. [Symptoms] Symptoms: no power under 3K RPM; poor power after 3K RPM; no engine response, very slow response; will not brake-boost past 2 psi; idle fluctuation between 750-1200RPM; rough idle; engine makes loud bog noise from intake when throttle is opened and takes several seconds to respond, even in neutral. Does not seem to get terrible gas mileage, but could be better. Does not smoke white, blue or black. Spark plugs are white on the electrode and have black carbon around the face.

[Duane Hoberg] Based upon an age-old experiences, it appears that your ignition timing is off (late)and is not responding properly contrary to what the base timing light indicates. The plugs with white center indicate a lean fire condition, the black ring indicates a rich, incomplete burn cycle. ie, fuel being burned late in the power stroke or after the exhaust valve is open. Late ignition timing. The ECU via the O2 sensors is leaning the mixture out after they enter the cycle because of the excess oxygen from the interupted incomplete burn after the exhaust valve opens. Causes: Ignition wires not in the proper sequence. Certain engines will run but with little power if two ignition wires are swapped. Has the flywheel been removed and replaced lately? Flywheel off by one bolt or backwards would cause a lot of problems. If the flywheel and everything else is on the money, the ignition portion of the ECU is at fault. Verification via diagnoses step by step with a Volvo Service Manual would be well worth the 20 or so dollars for the manual.

Symptom: Engine with flywheel rpm sensor (LH2.4 or Rex/Regina) will not rev above a certain rpm. Solution: while changing the timing belt, the owner used a screwdriver to secure the flywheel, inadvertently bending the rpm sensor plate. Once that was repaired, the symptom disappeared.

Intermittent Ignition Shutoff: FI Relay or Ignition Switch. [Inquiry:] I have had my Volvo 760GLE for over a year. Currently it has 214K miles. Lately it has been cutting off (the ignition) while driving. It happens only when the car is warm, say 10-15 minutes after driving. It first started while driving on the highways. Without any prior signal it would abruptly shut of f. (indicated by all the dash lights coming on) once or twice it start back up on its own a second or two while still cruising and I would drive as usual. Sometimes I would coast it down to the side of the highway, try starting a few times, wait, try again, and it would start again. By the way it shuts off, it seems very unlikely that it is a fuel system problem (does not sputter or hesitate, just shuts off abruptly) Looks more like an ignition problem: could it be the ignition module, coil or simply a poor ground ?

[Response 1:] Try removing the fuel injection relay and replacing. Your symptoms sound very much like a failing FI relay. Many of them fail through solder fatigue on the back of the board inside, and you can try to R&R the unit by resoldering where you see cracks or dull solder. FYI, the FI relay is above the fuse board under the cigarette lighter. Take off the pop-on cigarette lighter cover, remove the two screws holding the storage box and pull the box out. You then have full access to the relays. The rectangular white one in the middle row, driver's side, is the FI relay. (Green relay on some 940SE and 960 cars.) I carry a spare relay around in the back of my 1990 740 in case of failure on a long trip. They seem to last around eight to ten years.

[Response 2:] In addition to the fuel relay mentioned the ignition switch can do that to you and it is certainly a candidate to be failed at 214K miles. I would replace it and see, if it's not that then it won't be wasted effort as it will fail soon if it has not already. The switch can somewhat be checked by twisting ignition key a few degrees either way the next time it does its shutdown number on you.

Unexplained Driveability Problems in Regina-Equipped Cars: Corroded Coil Ground Connector. [Ron Lynes] My Regina-equipped 940 seemed to miss a little

in the 2000rpm range especially on partial deceleration. The emissions test failed on CO,HC and NOx at 25mph and passed at idle. After replacing many parts and asking at Brickboard, I decided that the coil ground might be at fault. I had assumed the ground for the coil was to the body right where it is mounted, but as I followed the black ground wire along the body I noticed a ground that I had missed completely by the headlight - I even looked for this one a couple of times. Iit was buried under the harness and guess what - corroded like crazy. 10mm socket and some sandpaper later and it looks like all my symptoms are gone. [Editor] Use conductive grease ("OxGard") to protect your chassis ground planes from further corrosion.

Unexplained Driveability Problems with ECU Error Codes; Oxidized Connectors. The recent steamcleaning problems with a 240 and connector problems with another 240 bring to mind a recent Volvo Tech Service Bulletin from March, 1993 which describes a procedure for cleaning, de-oxidizing and protecting engine electrical connectors to eliminate driveability problems when unexplained error codes appear at the ECU. Apparently, they started using protective grease at the factory in 940 chassis numbers 128400 and 945: 079100; before this, the connectors are unprotected. No 7xx cars have grease applied at the factory. It helps to have a Volvo wiring diagram at hand to locate all of the appropriate connectors, each of which has to be disconnected, cleaned and greased. Be careful in removing connectors, since the plastic connector and the wiring insulation can harden and become brittle over time. You use a cleaning/deoxidizing spray such as DeOxIt from Caig Labs or Chemtronics Tuner Renu (available at electronic stores) and a low-temperature silicone dielectric (non-conductive) grease for electrical connectors, available at auto stores. Don't use OxGuard, which is conductive. You turn off the ignition and disconnect, clean and grease the following connectors leading to the sensors noted:

- RPM sensor at back firewall near brake booster
- MAF sensor at the AMM
- Power stage at fender
- Knock sensor beneath intake manifold
- ECT sensor near flame trap
- Throttle position switch on throttle body
- EGR temperature sensor (California cars)
- IAC valve beneath throttle body

The deoxidizing spray is applied to both connector halves, then you squeeze the grease in and around the connector (but don't fill the protective boot), then reconnect. After everything is back together, you turn on the ignition and start the engine. They note that this procedure is supposed to be used for driveability problems or if oxidation is noticed, but I can imagine that it would be good practice as a PM technique on higher mileage engines on older 240/7xx cars. If you go to this trouble, then you might also follow the advice on maintaining engine and chassis ground connections, which also corrode and lose connectivity.

CAUTIONS: DON'Tdo this to the oxygen sensor connector which operates at millivolt levels. DO NOT do this to any SRS/Airbag/Seatbelt connectors: these are all gold-plated and do not oxidize. If they get dirty from spilled drinks, etc., just clean them with a no-residue cleaner.

Unexplained Driveability Problems: Rotten Battery Cables. [Editor:] If your car is not idling correctly or shows strange error codes, including ABS warnings, see the 960 and Circuits sections on rotten battery cable connectors. These corrode away and reduce voltage to the car electrical system, causing ECU and control problems, including possible problems with engine sensors.

Unexplained Driveability Problems: Bad Voltage Regulator. [Tip from Zach Gurley] Bad voltage regulator symptoms on a 740:

- pulsating lights (not necessarily rpm-sensitive)
- the car lunges and jerks, especially when in gear and coasting (similar to the feeling of disengaging the clutch too quickly)
- intermittent engine spit and sputter at a specific rpm in any gear including neutral (mine was at 1900 rpms)

It took me a while to figure this one out. Of course I figured the voltage regulator might need to be replaced because of the pulsing lights, but no one thought the problems were related to the violent sputtering I was getting. Apparently, the regulator was having difficulty coping with the additional power produced from a faster moving alternator, which was in turn messing up the ECU. The brushes were in good shape, but the regulator was an aftermarket brand, so it could be an isolated problem.

Car Runs but Won't Re-Start; Bad RPM Sensor. I recently posted a starting problem with a 1991 240, where it would start fine when it was cold and would start fine hot if restarted immediately after cutting off the engine. However, if it were left for 10 minutes or more after cutting it off hot, the starter motor would just turn and turn until it finally started - sometimes it did not and the battery just ran down. As it turns out, it was the RPM sensor, which is also a crankshaft position sensor. The heat soak after turning off the engine made the sensor open circuit most of the time - during starting, apparently, the computer did not pick up enough crankshaft position information to start the car. However, since the car ran fine if it did start, the sensor must have been intermittently putting out a signal, enough to update the computer in order to correctly operate the fuel injection and ignition systems after starting. After replacing the sensor, I have had no further problems with starting. [Chris Herbst] If the car stalls while turning corners,check that the rpm sensor wire isn't split open and grounding on the rear of the engine somewhere when you turn corners or slow down.

Car Stalls When Brakes Applied: Vacuum Leak or FI Relay. [Inquiry:] I am having a problem stalling under hard braking. I have had it checked for vacuum leaks and they appear OK. It only happens when the car is warm and I apply the brakes hard.

[Response 1:] I would look in the direction of the power brake booster. Right after you brake, you fill up the booster with air, which has to be evacuated by the engine. If your idle is somewhat shaky, throttle plate is out of adjustment or you

have a lazy idle air motor the idle can drop enough to stall it. The check valve in hose from intake manifold to booster has an arrow on it indicating the direction of installation Take it out of the line and suck on it to see it opens and shuts correctly.

[Response 2:] Check the solder joints on the fuel pump relay. Cracked joints will sometimes cause a warm relay to drop out when the engine speed drops and the alternator slows and the system voltage drops.

Car Stalls at RPM: FI Relay or Hall Sensor. [Inquiry:] Car is 1986 740T with B230 engine and A/T. Occasionally, while accelerating, RPM at approx. 2500 the engine will start to hesitate, choke, and die. I pull over to the side of the road where it will restart on first attempt. I take off and all is well for days and weeks. I thought that once the engine shuts off, and the car still moving from inertia I could move the shifter into Neutral, and restart the engine. Starter will Not even engage. However, with the car stopped, it will start in Neutral. Why is this ? Fuel pump relay is about a year old. Other than this, car runs and idles fine.

[Response 1: FI relay] It sounds like the fuel pump relay is cutting out. Behind the ashtray is the fuse box and relay panel. About the ashtray should be the lighter and a storage bin. Pull the lighter out and remove the square piece of trim , there are two screws , remove them and the whole box should come out. The fuel pump relay should be the relay located directly below the big red round one. It is rectangular and white (green in some 940SE and 960 cars.) The current p/n is 3523608 . The relay should have six terminals on it.

[Response 2: Hall sensor] The easiest way I know of checking the distributor is to remove it with the plug for the pickup still attached. Turn the key to the run position, and spin the dist. If the injectors start clicking the pickup is good. If the pickup is bad , good news bad news. The good news is there is a replacement pickup p/n 1346792 (the black plastic plug is also available it doesn't come with the pickup p/n1346793) The bad news , the pickup is riveted to the distributor body, and you run maybe a 50/50 percent chance of breaking the housing. A rebuilt distributor is available from Volvo it comes with a new cap and rotor, but more importantly a new shaft seal in the housing that is not available as a spare part (dist p/n 8111214) Either way get new o-rings for the dist. p/n 969330 & 969331.

Rich-Running Problems:

Rich Running Problems: General Diagnostic Notes. [Tips from Duane Hoberg] For the LH system injectors to function properly, three items are sampled at all times and are used to determine the injector pulse time based upon the fuel pressure at a specific pressure. Those items are critical to a normal running engine.

Causes of Running Rich Problems in LH Systems.

- High fuel pressure. Check fuel pressure. If the fuel pressure is out of spec the engine runs rich or lean until the O2 sensor compensates if the range is not that far out of spec. This shows up as a cold running and start problem that

may go away when hot with an adverse effect on gas mileage.

- Check injectors to make sure they are closing. If your crankcase oil is full of gasoline, you probably have an injector that is failing to close.
- Fuel check valve on front of fuel pump. If stuck part way, it restricts the flow which causes a lean condition. Mechanics may have compensated by adjusting the AMM. This cured the hot running condition but did nothing for the cold start. As the valve restricts or opens further, the car runs like crap. If suddenly opens full, the car will run rich. Associated symptom is it takes a long time to start first off in the morning. Normal time should be no more than 3 seconds. Anything longer and there is a problem. If you test fuel pressure at the rail and residual or resting pressure is zero, the check valve has failed.
- Temp sensor for the ECU is bad or out of specification or its ground is faulty. From cold to hot the engine needs different amounts of fuel to run efficiently. The sensor that determines this info needs to be consistent across its range. If at various points it is out of spec, open or full closed the engine computer responds appropriately and adjusts the pulse rate which will lean out or flood the engine. Measurement is remove sensor, cool it in freezer, attach ohmmeter, place in cold water on stove and heat to boiling while watching meter, needle movement must be smooth over entire range. Final test is in engine at full operating temperature with test point at ECU connector. It must be with 10 to 15 ohms of the chart in the various service manuals.
- Faulty AMM. Amount of air is determined by AMM. If the meter is out of specification the ECU will cause the engine to run rich or lean. A slight out of spec can be compensated for by adjusting the mixture control. If adjusting the mixture control does not work AT ALL engine running conditions, then replace the AMM. Obviously, any air entering downstream of the meter leans the mixture. An exhaust system that is not tight or partially plugged changes the amount of air that can move through the engine and changes the running parameters of the engine. Adjusting the AMM can compensate until the specs shift too far and then engine performance and running problems abound. Make sure the charcoal cannister is not faulty and allowing engine vacuum to suck fuel from the tank to the intake manifold through it. A definite rich condition.
- O2 sensor out of spec or damaged. Once the sensor gets to operating temp, it provides a compensating signal to the ECU which is still running the engine based upon air mass and engine temp at a specific fuel pressure. The ECU is constantly looking for this signal after a certain engine temp. Once found it uses the signal from the O2 sensor to adjust the pulse rate to control emissions.
- [Turbo models] A loose Compressor Blowoff Valve at the mounting bracket on Garrett turbos will leak on boost and give a VERY rich mixture, as will any holes in intake air hoses, pipes or the intercooler.

The idle control valve only controls idle. It allows measured air to bypass the throttle plate based upon a specific fuel pressure and the tach signal.

[Jeremy] Here is a quick trick to start a flooded car: Disconnect the four injector electrical plugs and crank with the pedal mashed to the floor and burn out the extra fuel and then reconnect.

Car Stalls; Bad Fuel Injection Relay Likely Cause. [Variety of car won't restart or is driving along and stalls abruptly problems.] There have been a number of these problems recently--the car won't start after I drive it 20 minutes, the car won't start after I turn it off after driving a short distance unless I wait several minutes, the car made me wait 20 minutes at the grocery store then started and ran fine...ones like this, that all sound to me similar to the problem that afflicted me a while back, which was cured by a new fuel pump relay. My problem was sporadic, and the symptoms varied, but boiled down to a well-running car simply, now and then, refusing to start. Given that it now seems clear that the Fuel Injection Relay is fairly often culprit in these cases, and given its low cost, I'm wondering if maybe trying to repair or replace the fuel pump relay, after checking for loose wires and that the fuses are intact, shouldn't be the first line of attack.

Car Stalls During Turn; Bad Fuel Pre-Pump Likely Cause. See Fuel Pre-Pump Problems for more information about pre-pump problems causing odd stalling situations. See also the information above on crank position sensor failure.

Poor Performance; Rich Mixture Smell: Diagnostics [Inquiry: Jarrod Stenberg] My non-turbo, auto transmission car has been running real crappy for a while now; I think it was gradual. Sometimes when I start it it takes forever. This can include some backfiring. When it finally does start it sometimes spits out a cloud of smoke. It often smells like gas as well. Seems to be running rich. The oil smelled like gas. I replaced it since this scares me for good reason. Of course this improved nothing but my peace of mind. When idling it will race a bit and cycle back down to near stall (to and fro to and fro but not REAL bad). Things I have checked and symptoms: Weak spark? Replaced the plugs and I have new wires. Checked the distributor cap and rotor. All are good. I have done the easy checks for vacuum leaks: sprayed wd40 around and listened for the engine to choke on it. I am pretty certain this is not it.

[Diagnostic Notes: Don Foster]
Failing FPR. First, it certainly could be a failing fuel pressure regulator. Pull the small vacuum line and sniff for gas -- possibly the diaphragm has a pinhole and is bypassing fuel directly into the intake manifold. But even if no gas smell, the regulator could have increased the fuel pressure creating an always-rich condition -- this is not uncommon.

Failing ECT. Second, my favorite is the connections at the temperature sensor -- the two-connector sensor under intake runner #3. (The single connector sensor under runner #2 is for the dashboard temp gauge.) This sensor uses an NTC (negative temperature coefficient) thermistor. When the temp is low, the resistance is high, and when it's hot, the resistance is low. The FI ecu adjusts the injector pulse duration based partly on this reading to compensate for engine temperature. So a failed sensor, a bad or broken connector, corroded connections, or broken wire would create very high resistance and simulate a very cold engine (like minus 50 degrees). The ecu would adjust fuel delivery accordingly.

Bad Air Mass Meter. There's always the old limp home trick. If you find the engine runs well (with the AMM unplugged) above about 30-35 mph, then you probably have TOO much fuel pressure. If it were my car in this case, I'd suspect

the regulator. But if the engine can't get above 30 mph, more or less, then it's probably the AMM.

Injector Ground Wires and Harness. [Don Willson] Check the ground wires on the injectors. Remove the manifold bolts and solder the ground wires to the crimp lugs. Wire brush the connector and around the manifold bolt and tighten the lugs down securely. A smart mechanic said this is the first thing he fixes on any European car that comes in. When these ground wires develop a high resistance an injector starts to misfire sending excess oxygen to the O2 sensor which it thinks is a lean condition and calls for more gas. Let us know if this works.

[Mark Stites] In one situation, the injectors were constantly grounded, causing massive flooding and engine stalling. Before concluding that the ECU is shorted internally, consider that a more likely culprit is the harness. It has been years since I have seen one do it but, in the harness under the intake manifold there is a splice where all of the injector grounds come together. I have seen a harness deteriorate to the point where that splice shorted to ground and kept the injectors on continuously. There are a couple of connectors under the brace that runs from the firewall to the passenger's strut tower, under that brace you need to find the 8 pole connector that has a gray wire in the #7 position. Leaving the connector connected, pop open the back side of it and slide out wire. Turn the key on and if it continues to barrel fuel then your problem lies between the injectors and that wire connector (i.e. it's in the harness somewhere). If you turn the key on and it no longer runs the injectors then it is being grounded somewhere between the connector and the ECU, most likely the ECU.

Poor Perfomance, Bad Acceleration: Faulty FPR. [Inquiry: Aidan] I have a problem which I just can't seem to figure out- what would make my '89 744 GL with just a tad over 105k go from running beautifully smooth to not-so-good nearly overnight? Basically, the car has been running great for a couple of months, ever since I had some (relatively) minor work done on it. Everything has been absolutely wonderful- until yesterday evening. Literally, all of a sudden the car started giving a great deal of resistance when I would accelerate- the RPM's would jump back and forth like crazy, and the car would shudder and jerk when accelerating and idling... (like, say, at a stop light.) This is all while the car has a full tank of gas. It began to do this pretty much as soon as I started the car, but continued even after it had been running for about an hour. The temperature just dropped a great deal up here in MA, and as it was late at night after getting home, I didn't really have a chance to take a look at it. I didn't use the car again until tonight, so it had been sitting cold for about 9 hours. When I tried it was VERY hard to start, so hard that I feared that for the first time ever I wouldn't actually be able to get it started. When it did start, the engine jumped around a great deal between .75 and 2 RPM's while in Park, and the car continued to shudder a great deal even after the engine had warmed up and was put in both Drive and in Reverse. The car seems most unresponsive to acceleration when the engine is running under 2 RPM's, though trying to accelerate causes the same reaction from the engine at nearly any speed/RPM. After taking a look under the hood, I noticed that when the engine can be seen shaking a great deal more than it should, literally jerking itself back and forth. It often sounds like the engine is just going to cut out, only to rev up again. (it repeats this process indefinitely, warm or cold.)

Without saying, the car is very difficult to drive like this, and I fear that one of these times its either just not going to start, or going to cut out while driving- both things I'm not looking forward to. Does anyone have any suggestions about what could cause it do this, or have any ideas about what I should be looking at/for? Any help/ideas/suggestions would be MUCH appreciated!

[Final Diagnosis and Fix: Aidan] After fiddling around and trying a variety of different things, I've come upon what seems to be the solution- a faulty fuel pressure regulator. After replacing it first with a test part and finally a new one for $58.87, I have not experienced any kind of problem in running, idling, or starting. I came upon finding it pretty much by trial and error- the AMM checked out and appeared fine, as did the thermostat in the air filter.

Engine Hesitation: Bad Fuel Pressure Regulator. [Symptoms:] occasional stalling engine at idle; occasional stumble at cruising speed, resulting in 1-2 seconds of deceleration like I'd turned the key off.

[Diagnosis:] The bottom line is the fuel pressure regulator was bad, causing too high pressure; replace pressure regulator. This whole problem was compounded by the fact that there isn't a commonly available pressure gauge that fits a Bosch FI system; even my mechanic has a homemade one. I delayed and delayed getting the gauge in place, which would've immediately solved the problem when it first started occurring! Excuses: I was unable to get the fuel rail to unbolt from the hose to the pump either, so I eventually cut the fuel line itself, which was a two-piece construction (rubber outside, poly liner inside). I purchased Sunpro ($35) fuel gauge because it had a hose (with GM/Ford fittings) that I could remove; and I basically purchased one of every part at the local plumbing supply shop. Anyway, putting the gauge in instantly revealed too high pressure. Jumpering the fuel pump was easy too. And nothing could've been easier than replacing the pressure regulator -- two screws and it's out. The hardest part was swallowing the $80.00. Note: Imparts carries nice 1.5" fuel pressure gauges (you mount them directly in line) #153008 60psi - 1/8" 27NPT connection $21 USSummit carries nice small aluminum connector for those gauges - hose to hose to 1/8" 27NPT thread - part # SUM-G1710 $5.99 they have gauges at the same price as well.

Note: I had a hose assembly made at the local hydraulic shop. the fittings were made by GATES (the hose people) The sizes are 14mm with a 1.2 mm/pitch and a 37(?) degree JIS flare.

[Another Tip from Mike W.] Some of you may recall that I posted a week or so ago regarding my car which had been idling roughly. LH 2.4 OBD was giving me 1-1-3 (fault in fuel injectors) and 2-3-2 (fuel system compensating for rich or lean mixture at idle). After chasing down numerous red herrings (IAC, TPS, AMM, ECU, cold start injector, coolant temp sensor) the problem turned out to be a bad fuel pressure regulator. I've experienced two failure modes for LH-jet FPRs; the first where inadequate fuel pressure is delivered and fuel comes out the vacuum line connection on the front of the unit, and the second (which occurred in this case) where the unit simply pressures up to the point that NO fuel is let out the return line side and excessive pressure is delivered to the injectors (hence the OBD code). Easy to test, just disconnect the return line to the tank from the back of the FPR and connect a couple feet of hose. Aim the hose into a gasoline safe container and

turn on the engine. You should get a good strong stream of fuel from the return line at idle, probably something like a half gallon a minute or more. If you get little or no fuel, the FPR is bad, and your main fuel pump will run hot and start screaming for attention pretty soon. Also found out that this same FPR (Bosch 0 280 160 294) is used on both the LH 2.4 in the 240 and in my wife's '94 940T. Now I need to go by the pick and pull to get a spare for my inventory.

Fuel in Oil: Faulty FPR or Injector. [Inquiry:] My brother's 740 with a B230FT has gas in the oil. I lent him my fuel pressure gauge to check for over pressure, guessing that it was a bad fuel pressure regulator. Bad news is that his pressure is right on the money, I think he said about 45 psi. Anyway, the only thing we could think of is a leaky injector that's dribbling when the car's off. The problem with that diagnosis is that if gas was leaking from an injector, the car would take a few extra turns to start in the morning since fuel pressure would be down. He says that it starts right up. I should probably have him leave the pressure gauge on overnight and check the pressure in the morning. Anyone have any ideas?

[Response: Steve Seekins] There are only two sources for fuel in the crankcase. First one is the fuel pressure regulator - however, this may not affect the working pressure! With the engine running, disconnect and plug the vacuum line to the intake manifold. If fuel comes out of the regulator vacuum line, there is a hole in the diaphragm and that is the source of the fuel. Replace the regulator and change the oil and filter. This is a fairly common problem.

The second source of fuel in the crankcase is an over-rich engine. First, if this is your problem, your mileage will be terrible - on the order of 12 to 16 mpg. If so, it can be EITHER leaking injector OR a clogged injector, or possibly a bad oxygen sensor. Leaking injector can be checked by removing the injectors, leaving them connected to the injector rail. Cycle the fuel pump several times with the starter, then wipe the injector tips and observe for droplets forming. Also, have someone crank the engine while you observe the injector spray patterns (CAUTION: RAW FUEL WILL BE SPRAYED. BE SURE TO DISCONNECT THE SPARK AND OBSERVE SAFETY PRECAUTIONS.) Look for spurts, squirts, etc - basically anything other than a nice even cone-shaped spray. Poorly atomized fuel may not burn completely and result in some fuel getting to the crankcase. Also look for a CLOGGED injector. A clogged injector will make one cylinder run very lean, but the computer which looks at the average will try to compensate by richening up ALL injectors and net result is engine running very rich on 3 cylinders and lean on 1 cylinder. Don't forget to check the cold start injector if installed - some engines have them, others do not depending on year and type of injection system.

Other Running Problems:

Car Stalls Repeatedly on Startup: Fuel Pump Check Valve. [Inquiry:] I have a 1985 740 GLE and every morning when I start my car it will stall approx. 3 times before leaving the driveway. After this it works fine, and if I park the car and then come back a while later it starts right up and is fine. It just seems to have a problem when it's been sitting a while, i.e. overnight and getting to/leaving for work. It has new Bosch platinum plugs as well as new ignition wires. And this

problem occurs regardless of the temperature both summer and winter in upstate NY.

[Response: Steve Seekins] This sounds like a classic fuel pump check valve problem. The check valve is there to prevent the fuel from draining back to the tank when shut off. In the AM, try ticking the starter just enough to make the fuel pump run for a second or so - but not enough to start the car. Do this 3 times, then start the car. If it starts and runs normally without stalling, replace the check valve located back at the fuel pump. Other things to check - make sure that throttle body is clean, check injector seals, wiring harness, etc. Clean, replace, repair as needed. Consider running a can of BG44K through the fuel system to clean it -particularly if this car has not had regular maintenance of the fuel system.

Car Stalls, Lights Die: Electrical Ground Fault. [Inquiry:] Does anyone know if the bulb out sensor box can cause a dim headlight intermittantly. Sometimes if at a stop light or parked, if I turn on the brights the engine will die. Also sometimes the rt. turn sign and bright indicator on the dash appear to be dim when they shouldn't be lit at all.

[Response:] There is a ground bar on each inner front fender. Make sure all of these wire connectors are clean and tight. I forget what else grounds here but a dirty/loose ground at this grounding point will cause the engine to die and also dim headlights. Check both ground points for the inner fender area for being loose and/or dirty.

Car Over-Revs RPMs While Under Acceleration. [Inquiry] I occasional get an over-rev when accelerating hard. The car is a 940 Turbo with a manual transmission and overdrive. Typical symtoms appear when I accelerate in third or fouth; there is an increase in engine revs without the increase in speed.

[Response: JohnB] The condition is called "flare"; you have clutch slip or clutch slip in the overdrive unit. Bring it up to 50mph in 3rd or fourth (somewhere around 3500 rpm, your choice/speed) and use full throttle with your other foot on the brake to maintain speed....engine speed should not increase.

LH-2 Cold Idle Problems -Bad ECT or O2 Sensor and Wiring Harness Notes
(BB)The block temperature sensor (ECT engine coolant temperature sensor under the intake manifold) plays a big part in cold running decisions and could pre-maturely allow the O2 sensor signal being used before the engine is warm. Because of this a cold idle problem rarely involves a faulty O2 sensor, but may involve the temp sensor and more specifically the wiring at the temp sensor. My experience is that this usually leads to quite rough running at all times, but fast idle and poor acceleration are known symptoms. With the ignition on and all wiring in place, you should see voltage at the temp sensor terminal connected to the blue (or orange) wire that goes back to the ECU. See Diagnosing ECT Failures for more information. No volts means broken wiring or bad ECU. A bad ECU may actually just be a bad ground at the ECU, so be warned. A cold engine should read 2-4 volts, a fully warmed engine 0-2 volts. If you see the full supply voltage of 4-5 volts (the reading you should get from the ECU when the connector is pulled off the temp

sensor) then the temp sensor or its ground wire are faulty.

The temp sensor wiring goes into the wiring harness and along the firewall before joining with the O2 sensor wiring and going through the firewall to the ECU behind the right side kick panel. If you have a general wiring harness deterioration problem then a fair bit of digging and careful tracing may be required to isolate the problem. You can splice in your own repairs, but for extensive problems a total wiring harness replacement may be needed.

Automotive wiring from your local retailer is often not up to the job of being near a hot engine. If possible, make your splices using heat resistant wiring (like oven/stove wiring from an appliance parts/service shop). Also use heat resistant connectors (nickel or copper) rather than auto grade (aluminum), you should be able to get them at the same place. Heat shrink tubing can be used to insulate the connectors and can also be used to insulate short runs of bare wire. Better quality shrink tubing is available from electronics/electrical or appliance supply houses.

BTW Cheap PVC clad wire, electrical tape, shrink tubing, dielectric grease, etc. should not be used at the O2 sensor lest it melt and burn from all the exhaust manifold heat. If in doubt, test a scrap for heat resistance.

So, with wiring harness problems in mind, resolve to keep your engine compartment a little cleaner so that engine oil and road grunge buildup on the wiring doesn't hasten deterioration of the insulation. If your engine is weeping oil onto the head then get the valve cover gasket and/or camshaft seals attended to. You don't have to become a fanatic and start waxing the firewall, just use detergent and an old wash mitt and maybe the occasional spray-can of engine degreaser. When rinsing off, avoid drowning your distributor and ignition control unit. Everything else is pretty much waterproof (actually the ICU is also normally waterproof, but why take chances).

Car Won't Start: Neutral A/T Safety Switch at Fault. [Inquiry:] Starter will not operate when ignition turned to start.

[Response:] I've had a starting problem with my 89 744GL, and discovered that the 'neutral safety switch' was the culprit. It's a device in the base of the (automatic) shifter that will only allow the car to start in neutral or park. Mine had worn to where the contact wasn't always made in neutral or park either, so I bought a new one at the dealer ($48) and it was simple enough to install.

Car Won't Start; Plugged Catalytic Converter. I hate to post another my car won't start question, but my car won't start! This is an '87 240 B230F, 196k miles, LH-J 2.2, Chrysler Ignition with Bosch Distributor. The car cranks over properly. Fuel pumps both verified running. Injectors generate clicking noise indicating operation. Measured resistance of all 4 injectors - all correct. Sparks happen at spark plugs. Verified distributor points at #1 when both #1 cam lobes point up. Spark plugs fire at correct time (as close as I could estimate with timing light.) Tested all I/O to ECU - all points had correct continuity/resistance/voltage per Bentley testing procedure. Tested Air Mass Meter - proper voltage & resistance on all points; no change when unplugged. Tested fuel pump delivery volume - ok.

Checked resistance of coil - within spec. Suspected gas; drained tank and fuel lines, and added 3.5 gallons of fresh fuel. Installed new Cap/Rotor/Plugs/Wires. Verified proper operation of throttle switch. Compression good at 190/190/190/180. Two instances of flaky wiring noted, on oil pressure sensor and temperature sensor; verified both not shorting or grounding. All other wires look clean and almost new. Still no go. At this point, the car *almost* runs when you crank it. It sounds like it would if you just cranked it for long enough, but it never does. Occasionally, after standing a while, it will run badly for 10-15 seconds before dying. Spark plugs are wet after cranking. I have run out of things to check - I'm stumped.

[Diagnosis:] Have you checked for a plugged exhaust system?

[Result:] I pulled the plug from the test port just ahead of the cat, and it started and ran, with a loud hissing coming from the port. I disconnected the catalytic converter at the inlet, and found that the cat had broken up inside. A large piece had bounced forwards and become firmly lodged in the inlet, blocking almost all flow. I removed the piece, and the engine started up promptly and ran very well, albeit loudly.

TURBO-SPECIFIC SYMPTOMS:

Turbo has Poor Acceleration; Diagnostics. [Inquiry:] Symptoms: When I give it gas the turbo boost goes into the yellow, however, acceleration is sluggish. The car fights me all through acceleration. It starts fine and has a new turbo.

Diagnostics: See the Engine: Turbo sections on Basic Diagnostics and the sections following for more tips. You likely have a leak in the intake system.

Turbo has Poor Idle, Poor Idle Speed Control: Leaking Intake Manifold Gasket. [Symptoms] At idle, my turbo sounds like it is missing on one cylinder when warmed up. It works better when cold. When completely warm, the idle hunts from 1500 rpm down to 800, back and forth. The engine appears to run fine at speed on the highway. [Diagnosis]. Leaking intake manifold gasket. The gasket mostly sealed when cold but not warm, allowing outside intake air in at idle but boosted air out under acceleration. Replacing it fixed the problem.

Turbo Suffers Severe Misfire: Leaking Intake System. [Symptoms] Passed someone on a two lane road at full power. A mile of two later the car starts to vibrate from what feels like the transmission, even when coasting. As we begin to accelerate the vibration starts again and it loses power. After I drop it into 2nd gear, it revs and seems to be running better. Go back into drive and drive the car gently, seems to be ok.

[Response: Jason R.] You blew or popped off a turbo hose: check those hoses. I had a small tear one time which would not let me get past 40-50mph but would run fine below that. [Editor] A leaking turbo hose will enrichen the mixture, causing misfire in multiple cylinders. Opening the throttle will worsen this significantly.

Engine Cuts Out; Rich Running: Turbo Electrical Harness Degradation.

[Tip from Jeremy] Symptoms in my turbo were cutting out and dieing when driving then restarting with no problems, not starting after sitting 8 hours and being totally flooded. Fuel was weeping out the manifold! The cause of my problems: The power wires from the injector to the turbo injection resistors were shorting together or to ground (note: non-turbo cars do not have these resistors). This would cause the injectors to open and stay open all the time in one or more cylinders. I found this by attempting to test continuity through the wires and in the process of disconnecting the next connector it would cause a loss of continuity in the connector I had just checked. Lesson- disconect all connectors so you don't get the chance for a false good reading due to an unknown short between wires. In another case, the wiring harness for the injectors was rubbing against the bottom of the valve cover and had worn through three of the injector's wiring. Now the solution: Replace the wires from the injectors to the resistor pack in the forward left side of engine compartment and the wires going to the connector that feeds thru the fire wall. The four wires going to the firewall connector are the signal wires that give a ground to the injectors. They all end up at the same pin so if you want to connect them at the injectors and just rum on wire to the plug that will work too. I routed the new wires along the top of the engine away from heat sources. Splice the new wires as close as you can to the existing connectors if you are not planning to replace them.

Turbo Stalls at Low RPM: Failed CBV Blow-Out Valve Diaphragm. [Jeff Pittroff] I chased a stalling at low rpm problem for longer than I will admit, and finally asked a local indie Volvo mechanic in my town (Jim Stevens in Cincinnati) And told him all of the things that I had tried to fix the stalling (no OBD codes; cleaned throttle body; swapped idle control motor; new fuel inj. relay; new RSR relay; checked for vacuum leaks; new AMM; new Crank sensor; new Power stage module). He suggested the CBV also called the blow off valve. I was skeptical, but desperate enough to try anything at this point. And sure enough mine had a 1/4 inch hole in it! I found a used diaphragm on Turbobricks and even though it was dry rotted and had some cracks, none of them were through to the other side. It worked, no more stalling! (I have since found another used one with no dry rot or cracks)

760T Misfires; FI Resistor Pack Defective. [Symptom:] My 86 Volvo 760 turbo is running very rough.. when I tested the cylinders the #2 cylinder wasn't firing. After many hours of frustration I found a relay which is located next to the battery. This relay is a little box with four cylinders in it The cylinders are about 3 inches long with a radius of about 3/8 of an inch. five wires go into the box One attached to each cylinder and one going down the center. I presume the lone one is the constant power. On this box I saw one wire was dislocated. I re-attached this wire but the cylinder still wasn't firing. I then took of another wire and the #4 cylinder stopped working. I then attached the working electrode (off the box) to the #3 cylinder but it still wouldn't fire. I also though have a periodic problem. Sometimes when I am driving normally my car will start to misfire. If I floor it will eventually

catch (3-4)seconds later. If I keep it floored it does go.. but when I release the gas to 1/2 it starts to putter out. Could this be the same problem? What is the name of this part?

[Response:] What you are describing is the resistor pack for the fuel injectors. Only the turbo's have them. The Volvo p/n is 3531339 and Volvo lists it for $59.39 dollars US. There is one resistor per injector. We have seen the batteries corrode the connector over a period of time, from the lack of battery maintenance.

Hot Start Problems: Faulty Hall Sensor. [Note from Steve Seekins:] Note that if your car is a turbo, you do not have the crank position sensor, but you do have a hall effect sensor in the distributor that can also be the problem (cars with the crank position sensor do not have the hall sensor in the distributor).

Hot Start Problem: Power Stage Overheats. [Note from Boris] I had a hot start problem on my car. It drove me bananas. I would pop the hood just slightly after each frequent stop, and this reduced the frequency of the problem drastically. Why do you ask? Volvos, especially the turbo models generate enormous amount of heat once parked after a drive. This heat has no place to escape. It just sits under hood for a LONG time and can damage various components. I believed whatever part was malfunctioning must be under hood and not on relay board. Replaced Hall sensor needlessly. Problem was in the Power stage. Took it off, cleaned the contacts very well, and coated with dielectric grease. Next, I coated the heat sink side of it with thermal compound which to my surprise was not there before. This helps keep it cooler. For extra protection I taped a styrofoam cup over it (Yes I too can be frugal.) Problem gone. I was stuck the other day going 11 miles in 3 hours, and the car ran fine. It was so hot under the hood, I could have baked a good lunch under there.

GENERAL EMISSIONS CONTROL PROBLEMS:

Emission Control Problems: High HC, CO or NOx. Below are some generic diagnosis notes (non-Volvo-specific) to help you begin pinpointing why you failed the smog/emissions/MoT etc. tests.

[Excerpted from Exhaust Emissions Diagnosis: The Precursor to Finding Engine Performance Problems, Larry Carley, ImportCar, June 2000.

GENERAL DIAGNOSIS. Elevated hydrocarbon (HC) emissions usually indicate ignition misfire due to fouled spark plugs or a bad plug. But high HC emissions can also be caused by burned exhaust valves (check compression), lean misfire (check for vacuum leaks, low fuel pressure or dirty injectors), or rich fuel conditions (excessive fuel pressure, leaky injectors or a dead O2 sensor).

High carbon monoxide (CO) emissions are a telltale sign of a rich fuel mixture. On newer vehicles with feedback fuel controls and fuel injection, leaky injectors, excessive fuel pressure and sluggish or contaminated O2 sensors are all possibilities to investigate.

Harder to diagnose are **elevated oxides of nitrogen (NOX) emissions.** NOX levels are affected by engine combustion temperatures. When the temperature inside the combustion chambers exceeds 2500°F, nitrogen combines with oxygen to form oxides of nitrogen, or NOX. Many engines rely on EGR to lower combustion chamber temperatures and reduce NOX formation to an acceptable level. When the engine is running at stoichiometric level (mixture at 14.7:1), NOX production ranges between 1700 and 2500 parts per million (ppm). Since NOX formation is a temperature-related reaction, lean mixtures cause higher NOX production. Mixtures leaner than 14.7:1 (stoichiometry) increase combustion temperatures and cause NOX production to increase. When the mixture reaches 16:1, NOX production drops off. To find the cause of NOX problems, you'll need to determine what's causing the engine to run too hot or too lean, or both. Causes here may include air intake or vacuum leaks; defective EGR valve, EGR vacuum solenoid or motor, or plugged EGR ports in the manifold; a failing or sluggish oxygen sensor; failing or contaminated air mass meter, carbon deposits in cylinders or on plugs; over-advanced ignition timing; fuel pressure too low due to plugged filter or failing pump; a failing catalytic converter; or engine overheating due to cooling system malfunction or overheated intake air due to air intake box thermostat failure.

IDLE EMISSIONS. A vehicle that has **sharply elevated HC or CO emissions at idle** will usually have a noticeable misfire and/or rough idle. The most likely causes here would be:

- Fouled spark plug(s);
- Shorted spark plug wire(s) or defective plug boot(s);
- Vacuum leak;
- EGR valve stuck open;
- Burned exhaust valve;

An extremely rich fuel condition can also cause elevated HC and CO at idle, while an extremely lean condition will only cause HC to rise abnormally. A leaky EGR valve can act like a vacuum leak and cause a lean misfire at idle. HC and CO will be somewhat higher as a cold engine warms up because the fuel system may still be running in open loop. Until the engine reaches a predetermined temperature and/or the oxygen sensor gets hot enough to produce a good signal, the ECU will supply a relatively rich mixture while the system is in open loop. A faulty thermostat that is stuck open or a defective coolant sensor may prevent the system from going into closed loop.

NOX emissions are always lowest during idle and decel because that's when engine load and combustion temperatures are lowest.

ACCELERATION EMISSIONS. During acceleration, the engine momentarily drops out of closed loop and receives a richer fuel mixture for more power. During this time (depending on the system), the Airflow Sensor and the TPS sensor play critical roles in controlling the fuel mixture. Most fuel-injected engines have either a throttle position sensor or switch that indicates when the engine is at idle. When this device indicates that the engine is no longer at idle, the on time of the injectors is increased to temporarily richen the fuel mixture. The same thing happens any time the engine comes under load and manifold vacuum drops. The AMM sensor tells the computer the engine is under load, and the computer

responds by adding more fuel.

It is normal to see some spikes in CO during acceleration, but unusually **high CO readings** indicates that the fuel mixture is too rich. Possible causes might include:

- Flooded charcoal canister or a leaky purge valve;
- Defective mass airflow (MAF) sensor, or
- Defective throttle position sensor.

If the feedback fuel control system is working properly and there are no apparent sensor or purge valve problems, the catalytic converter may be contaminated or not functioning.

Elevated HC readings during acceleration indicate ignition misfire under load. The causes could be:

- Defective knock sensor;
- Weak ignition coil(s);
- Excessive resistance in spark plug wires;
- Arcing inside the distributor cap;
- Worn, fouled or incorrectly gapped spark plugs;
- Over-advanced ignition timing; or
- Lean air/fuel mixture.

NOX readings will rise sharply during acceleration and will peak a few seconds after the cruising speed is reached. If the EGR system fails to recirculate exhaust back into the intake manifold, combustion temperatures will rise causing an increase in NOX. The higher temperatures may also cause some detonation (spark knock) to occur, which may be audible when the engine is under load. **Causes of elevated NOX emissions during acceleration include**:

- Defective EGR valve;
- Leaky EGR valve plumbing or control solenoid;
- Carbon deposits in EGR manifold passageways;
- Carbon buildup on pistons and in combustion chamber;
- Over-advanced ignition timing;
- Defective knock sensor or too low octane fuel;
- Engine overheating (check thermostat, fan, coolant level);
- Exhaust restrictions or failing catalytic converter
- [Chris Herbst] Check for low fuel pressure due to bad pump, clogged filter, or a bad (low pressure) regulator on fuel supply system.

CRUISE EMISSIONS. At cruise, the engine is lightly loaded and running at high rpm. Under these conditions, HC and CO should be low if the oxygen sensor and feed back control system are working properly, and the catalytic converter is in good condition.

High CO readings during cruise indicate a rich fuel condition. Causes here may include:

- Defective O2 sensor;
- Exhaust leaks upstream of the O2 sensor (check manifold gaskets and air

plumbing
connections);
- Defective AMM sensor;

High HC during cruise would indicate a steady misfire or loss of compression (leaky exhaust valve).

DECEL EMISSIONS. When decelerating, the engine will typically either lean out the fuel mixture or shut the fuel off completely (some fuel-injected engines). The computer typically uses inputs from the Vehicle Speed Sensor, TPS, Airflow sensor, and engine rpm to determine when this occurs. When the throttle closes and manifold vacuum shoots up, the computer cuts back on the fuel. Normally, HC, CO and NOX emissions drop during deceleration because the engine is no longer under load and is receiving little or no fuel.

If **CO emissions remain high during deceleration**, the engine is receiving too much fuel.
Causes may include:

- Leaky fuel injectors; and
- Faulty VSS, TPS, or airflow sensor.

Volvo Maintenance FAQ for 7xx/9xx/90 Cars
