

## **TUNED PORT INDUCTION INTAKE PLENUM AND RUNNER MODIFICATIONS**

### **1986 GM 'F' BODY LB9 - Other Models Similar**

Modifying the design of the original induction system can produce significant increases in performance and driveability. The original design of the system is sound, but mass-production techniques have caused poor fit and finish quality of the end product. Some important details were ignored by the factory suppliers due to production concerns, and most of these can be easily overcome with some tools, patience, and ingenuity. Aside from removing the restrictions in the air filter housing, this procedure is probably the single most important step to be made in improving induction system flow. It should be performed either before camshaft replacement, intake runner replacement, throttle body replacement, or cylinder head modifications or replacement, or done in conjunction with that work. Dynamometer results are varied, but peak power improvement of at least fifteen horsepower is attainable with this essentially "free" modification.

### **PLANNING**

Since the plenum will be removed for this procedure, this would be an excellent opportunity to perform other services which require removal of the plenum. These include fuel injector cleaning or replacement, EGR valve cleaning or replacement, Manifold Air Temperature sensor replacement, Adjustable Fuel Pressure Regulator conversion or installation, and vacuum hose replacement. This porting procedure should also be considered when performing any of these operations, as well as replacing cylinder heads, camshaft, lifters, or anything which requires removal of the intake manifold.

### **TOOLS AND MATERIALS REQUIRED**

Common hand tools including the following:

- T-50 Torx bit;
- T-15 Torx driver;
- Torque wrench;
- 10mm deep-well hex socket;
- Deburring tool;
- Gasket scraper;
- Ratchet and 6" extension;
- ½" deep-well socket;
- 15mm socket;
- 9/16" deep-well socket;
- 8mm or 5/16" nut driver, or socket;
- Chain nose or needle nose pliers;

Materials including:

- Die grinder or similar rotary tool;
- Grinding burrs;
- Rotary rasp or round mill bastard;
- Safety glasses or goggles;
- Dust mask;
- Anti-seize compound;
- Layout dye and scribe;
- Gasket set  
(FelPro 93035-1 or GM equivalent);
- Masking tape and permanent marker;
- Carburetor spray cleaner.

### **PREPARATION**

The procedure can be accomplished in one day, but it is best to plan to have the vehicle out of service for two days to accommodate unforeseen problems. Service manual allotted time for removal and replacement of fuel injectors is X hours. This procedure is similar, so the time allotment would be similar. Transportation to your local parts supplier should also be arranged, just in case. If you plan to do further repairs or modifications during this time, the total time would be adjusted accordingly.

**IMPORTANT!** If you have a Delco-Lock or Theft-Loc II radio, clear the radio security code before proceeding. If you have been experiencing any problems with the vehicle, perform an error code scan of the ECM to retrieve all stored codes. Disconnecting the battery for this modification will erase the stored codes and learned inputs from the ECM active memory. Once this has been completed, disconnect the battery negative cable and isolate it from the battery to prevent accidental contact with the terminal.

## **DISASSEMBLY**

Remove the Throttle Position Sensor and Idle Air Control stepper motor electrical connectors. Remove the throttle cables from the throttle bellcrank. There may be up to three cables with automatic transmission and cruise control. Remove the cable anchor bracket from the left side of the plenum. Remove the distributor trim cover from the rear of the plenum. Remove and mark the vacuum hoses from both sides of the plenum and the EGR vacuum line from the lower left side of the throttle body. Remove the air induction duct work and snorkel connecting the throttle body to the ducts. Remove the four bolts holding the throttle body to the plenum. Carefully move the throttle body away from the plenum. The coolant hoses do not have to be disconnected for this procedure. Remove the alternator drive belt, upper alternator bracket bolts, and bracket.

**IMPORTANT!** Clean the recesses of the large Torx bolts attaching the runner tubes to the plenum and intake base. Use a small screwdriver, compressed air, etc. If the driver bit does not achieve good engagement in the bolt recess, the bolt head may be damaged so that removal becomes impossible. Apply penetrating oil to the bolts to ease their removal.

Loosen the four plenum-to-runner bolts on each side of the plenum. Keep the bolts finger tight until all the bolts have been loosened. Remove all plenum bolts, and lift the plenum about two inches from between the two runner assemblies. The gaskets may have adhered to the plenum, so a little effort may be required to get the plenum loose. While holding the plenum up from the runners, disconnect the Manifold Air Temperature sensor electrical connector from the sensor on the underside of the plenum. Remove the plenum from the engine compartment. If you plan only to perform plenum porting, disassembly can stop at this point.

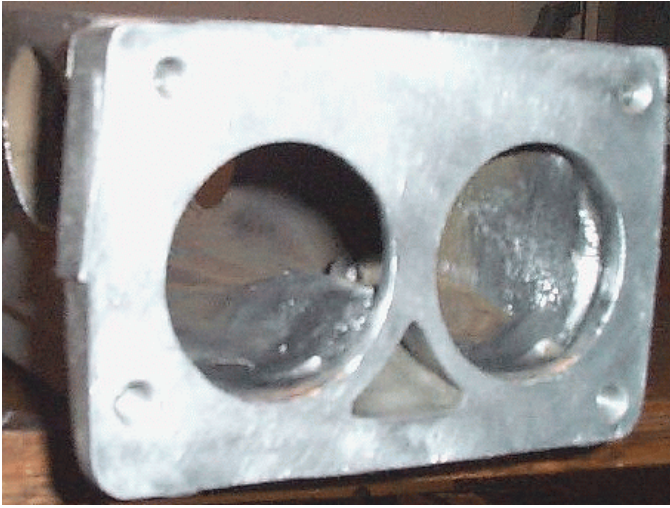
## **PORTING THE PLENUM - Throttle Body Openings**

Remove all traces of gasket from the sides and front of the plenum. Remove the MAT sensor from the underside of the plenum and store it in a safe place. You may also want to remove the vacuum hose fittings from the plenum to prevent damage to them.

Apply layout dye around all the port openings on the sides and front of the plenum and allow the dye to dry. Using the new gaskets and the bolts removed from the engine, mount the gaskets in their correct locations on the sides and front of the runners. The bolts should locate the gaskets in their correct positions. Using the scribe, carefully mark the outlines of the gasket openings on all surfaces. Remove the bolts and gaskets. Any grinding you perform will not go outside these lines. The throttle body openings at the front of the plenum will likely be the same size as the gaskets from the factory (52mm), or very close. Unless you are machining to install a 58mm throttle body, don't try to enlarge the throttle body bores on the plenum.

Set up the rotary tool with a large coarse grinding burr or rotary rasp. Put on your safety eye protection and dust mask. Mount the plenum in a bench vise or suitable fixture, taking care not to damage or mar the plenum. Begin grinding the floor areas of the plenum just inside the throttle body openings. A round mill bastard (file) or rotary rasp can be used to begin shaping the port walls and reduce the floor height faster than a grinding burr. There are large "humps" of material in front of the EGR ports in either throttle bore. These should be removed and blended flush with the floor of the main area of the plenum. Be careful not to alter the throttle openings at the front of the plenum.





Inspect the side walls of the plenum just inside the bores. You will notice that the walls converge sharply back into the main area of the plenum, creating further flow restriction. Continue grinding these wall areas so that the transition is smooth. Stop periodically to check the wall thickness of the plenum casting. Use caution around the bolt bosses just inside the throttle openings to avoid breaking through these areas.

You should notice a large single "hump" between the two bores at the floor that blends back about two inches. This is the top wall of the casting for the IAC passages. The sides of this part of the casting intrude on the throttle bores as they taper back into the chamber. This can be

ground and polished down to some extent to allow for a smoother transition from the round bores to the rectangular plenum. The sides of this mound should be ground back to allow straight air flow from the throttle bores. Be careful not to break through the casting. Blend the mound back into the floor area.

There have been some questions about removing the center divider between the two throttle bores. That center divider is not an impediment to intake air flow. Your throttle body has two divided bores, and taking out the center divider will create a sharp break right behind those bores. The result will be unnecessary turbulence and flow impediment right behind the throttle body - just what we are trying to resolve with this project.

The main areas on which to concentrate are the floors that shroud the EGR passages, and the walls that converge quickly back into the plenum body. Don't worry about the bolt bosses that intrude into the plenum area. Once the air has flowed into the plenum, it begins diverging instead of straight, laminar flowing like through the throttle body. The bolt bosses are not a significant interference to this.

Perform the same material removal at the sides of the plenum to match each runner opening to the gasket markings. Blend the openings back into the plenum area to create smooth transitions at each opening. Deburr all of the openings to remove the sharp breaks at each edge.

You have just removed the largest single restriction in the intake plenum. If that is your goal, the plenum can be cleaned of all chips and debris, and reinstalled on the engine. You can use solvents, high-pressure washers, or hot soapy water baths to clean and rinse away the debris. Rinse any dry the plenum, and blow out all bolt holes.

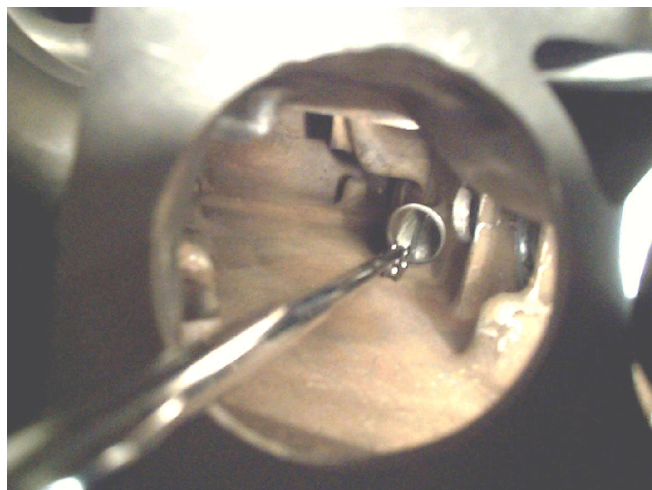
If you want to make further improvements to flow, read on. The next steps will require removal of the intake runner tube assemblies. This is not difficult, but will require additional time. Wiring harnesses will have to be moved away from the intake base, and the PCV vent tube will have to be removed. The Air Injection Reaction system diverter valve may have to be removed from its mounting to gain access to some of the lower runner bolts.

**HINT!** There is a bolt threaded from the inner area of the intake base plate which holds each runner assembly. Access to this bolt on each runner assembly may require some creative socket and extension combinations. The remainder of the bolts can be accessed from the outer sides of the runner assemblies. Clearance is tight at the lower bolts, but the rocker covers can remain on the heads if you use a 6" or longer extension bar on your ratchet.

If you decide not to perform these steps at this time, you have still made a significant improvement in intake flow. You can reassemble the plenum to the engine and enjoy the difference.

## **PORTING THE PLENUM - Intake Runner Openings**

With the intake runner tube assemblies removed from the engine, bolt a runner tube assembly to one side of the plenum, then inspect the port match through the other side and with a mirror through the throttle bores. If your rotary tool/die grinder is still available, you might want to match those more closely. The plenum openings can be enlarged to match the size and positions of the runner tube openings, and the runner tube openings can be shaped to match the plenum ports where they might overlap. Do a little grinding, then check the fit periodically. Use caution to avoid grinding back too far into the runner flange areas. The runner tubes have thin walls and could be broken through if caution is not exercised. Create a gradual radius at each opening to blend the two parts together smoothly. Enlarging the port openings past 1.575" is of little benefit since the tubes themselves have a design diameter of 40mm (1.574").



Again, do not break the dividers between the port openings. That material comprises the end of the tuned runner after everything is assembled, and is calculated into the length of the runner tubes. Unless you are intentionally trying to de-tune the TPI system, leave those alone. Shortening the runners will theoretically move the torque peak out of the lower RPM ranges to a higher range - just the thing our heavy cars don't need with stock differential gearing and the original torque converter.

The same process can be done on the lower runner openings that match the intake base ports. The intake base openings are slightly larger than the runner tubes, so material can be removed from the runner flanges to match these ports and create a smoother transition.

If you do match the runners, make sure you check the plenum/runner and runner/intake base gaskets. Both the GM O.E.M. gasket sets and FelPro gaskets are too small to allow port matching. My stock runners were matched at 1.565", and the gasket openings were 1.525" out of the box. That extra 0.020" ridge hanging inside the ports can impede the valve impulse waves, and ruin the resonance of the tuned system, inhibiting air flow.

These gaskets need to be enlarged so they are at least as large as the port openings. Gasket alignment can be checked by loosely assembling the parts with the gaskets in place as described above. Since the gaskets have steel liners, you'll need to grind or punch the openings to a larger size. The gasket fiber can contain some irritating materials, so make sure you use a dust mask if you grind the metal liners. If you have access to an electrical conduit punch, use a 1-1/4" trade size (1.660") punch to enlarge the openings cleanly. Just make sure you carefully center the punch in the openings. If you have used a conduit or chassis punch before, just align your cross-marks made on the gasket with the markers on the perimeter of the die. Recheck alignment of the gaskets before final assembly.

Similar port-matching can be done at the intake base-to-cylinder head areas. This would involve removal of the distributor, draining the cooling system, removal of additional wiring, and removal of the intake base plate. While additional improvement can be made in these areas, the factory match is not as much of a problem since the largest portion of the tuned runner's length is ahead of the cylinder head. The most effective port matching in this area would require removal of the cylinder heads and deep-porting of the intake passages in the heads. Once removed, the temptation would be to install larger valves and pocket-port the valve bowl areas. The next logical step would be to install a different camshaft to take full advantage of the valves and porting. The project could be continued all the way to the oil pan, so these instructions will stop at the intake base plate.

## **REASSEMBLY**

Assembly of the induction system is fairly straightforward. Just reverse the removal procedure and torque the fasteners to factory specifications as you proceed. Remember to replace the MAT sensor and vacuum hose fittings into the plenum ports before installing the plenum. Also, remember to plug in the MAT sensor electrical connector before bolting the plenum in place. This can be accomplished after the plenum is in place, but it is a lot easier to do beforehand.

There are several things that should be done as you reassemble. Coat all fasteners with anti-seize compound. If you had any difficulty removing ant fasteners as you disassembled the system, you'll know why. Before you reassemble, you may want to remove and clean the EGR valve, or replace it if you suspect it has been causing problems. If you ever plan to replace the fuel pressure regulator with an adjustable unit, this is a good time to at least study the parts and familiarize yourself with the process. You may want to consider removing the fuel rails and injectors for cleaning or replacement at this time, and check the fuel rail seals. This would also be an excellent time to remove the distributor clamp bolt and coat it with anti-seize, since these can get fused to the intake very easily. Access it a lot more difficult after assembly, and getting it loose and coated now will pay off in the future.

<b>TORQUE SPECIFICATIONS</b>	<b>FOOT/LBS</b>	<b>Kg/m</b>	<b>N/m</b>
Intake Runner Bolts - Upper and Lower	15-20	2.1-2.7	20-27
Fuel Rail to Intake Bolts	18	2.5	24
Throttle Body to Plenum Bolts	18	2.5	24
IAC Motor - 1985-1989	13	1.8	17
IAC Motor - 1990-ON	30 Inch/Lbs	0.4	4.0

Upon reassembly, it would also be a good idea to set the Throttle Position Sensor voltage, minimum air position of the throttle plates, and clean the Idle Air Control passages and pintle.

When the project is completed, reconnect the battery cable and start the engine. Check for vacuum leaks. Make sure the EGR vacuum hose is reconnected to the fitting on the underside of the throttle body. As mentioned, set the TPS and minimum air position if you have not done so recently. Remember that all error codes were erased when the battery was disconnected, as well as all learned sensor input ranges in the ECM. The ECM will relearn the engine sensors once the engine has reached operating temperature and the car is driven in various conditions for about 20-40 minutes. New fuel tables will be established during this learning, so if the engine doesn't seem to run "just right" immediately on start up, don't be discouraged. If you have a vacuum leak or a sensor problem, the ECM will eventually recognize a sensor problem and set a DTC. The vacuum leak will persist, and you'll have to diagnose the problem as you normally would. If you are careful when assembling the components, the new gaskets should seal everything very well.

Once this restriction is overcome, any subsequent modifications will not be hampered, and can be expected to yield their maximum advantage. You should now also have a better understanding of the TPI induction system, and be less intimidated by the problems you may encounter in the future.

Happy motoring!

*Vader - April 4, 2000*