

State of California
AIR RESOURCES BOARD

EXECUTIVE ORDER D-175-2
Relating to Exemptions Under Section 27156
of the Vehicle Code

HYPERMAX ENGINEERING, INC.
TURBOCHARGER SYSTEM

Pursuant to the authority vested in the Air Resources Board by Section 27156 of the Vehicle Code; and

Pursuant to the authority vested in the undersigned by Sections 39515 and 39516 of the Health and Safety Code and Executive Order G-45-5; -

IT IS ORDERED AND RESOLVED: That the installation of the add-on turbocharger kit manufactured by Hypermax Engineering, Inc., has been found not to reduce the effectiveness of required motor vehicle pollution control devices and, therefore, is exempt from the prohibitions of Section 27156 of the Vehicle Code for 1983 through 1987 model-year Ford Motor Company heavy-duty vehicles powered by a 6.9L Navistar International heavy-duty diesel engine and 1988-1989 model-year Ford Motor Company vehicles powered by a 7.3L Navistar-International heavy-duty diesel engine.

This Executive Order is valid for the Hypermax Engineering Inc.'s turbocharger kit which uses one of the following turbochargers:

1. AiResearch model 409900-2 with area ratio (A/R) of 0.96;
2. AiResearch model 465124-5004 with A/R of 1.15;
3. Holset Engineering model H2A7680E/FA019CA2 with A/R of 1.08;
4. Warner-Ishi model RHB7-9700VP28NFBRL552A with A/R of 1.10

Modifications to the OEM emission-related parts due to the installation of the turbocharger kit include replacement of the OEM exhaust system with a 3-1/2" diameter exhaust system.

Changes made to the design or operating conditions of the device, as exempted by the Air Resources Board, that adversely affect the performance of a vehicle's pollution control system shall invalidate this Executive Order.

Marketing of this device using an identification other than that shown in this Executive Order or marketing of this device for an application other than those listed in this Executive Order shall be prohibited unless prior approval is obtained from the Air Resources Board. Exemption of a kit shall not be construed as an exemption to sell, offer for sale, or advertise any component of a kit as an individual device.

This Executive Order does not constitute any opinion as to the effect that the use of this device may have on any warranty either expressed or implied by the vehicle manufacturer.

THIS EXECUTIVE ORDER DOES NOT CONSTITUTE A CERTIFICATION, ACCREDITATION, APPROVAL, OR ANY OTHER TYPE OF ENDORSEMENT BY THE AIR RESOURCES BOARD OF ANY CLAIMS OF THE APPLICANT CONCERNING ANTI-POLLUTION BENEFITS OR ANY ALLEGED BENEFITS OF THE HYPERMAX ENGINEERING, INC.'S TURBOCHARGER SYSTEM.

No claim of any kind, such as "Approved by Air Resources Board" may be made with respect to the action taken herein in any advertising or other oral or written communication.

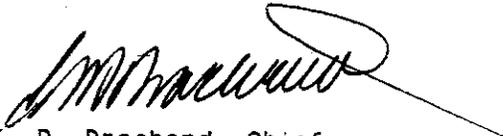
Section 17500 of the Business and Professions Code makes untrue or misleading advertising unlawful, and Section 17534 makes violation punishable as a misdemeanor.

Section 43644 of the Health and Safety Code provides as follows:

"43644. (a) No person shall install, sell, offer for sale, or advertise, or, except in an application to the state board for certification of a device, represent, any device as a motor vehicle pollution control device for use on any used motor vehicle unless that device has been certified by the state board. No person shall sell, offer for sale, advertise, or represent any motor vehicle pollution control device as a certified device which, in fact, is not a certified device. Any violation of this subdivision is a misdemeanor."

Any apparent violation of the conditions of this Executive Order will be submitted to the Attorney General of California for such action as he deems advisable.

Executed at El Monte, California, this 21st day of February, 1989.


K. D. Drachand, Chief
Mobile Source Division

State of California
AIR RESOURCES BOARD

EVALUATION OF HYPERMAX ENGINEERING INC.'S ADD-ON TURBOCHARGER
KIT FOR INSTALLATION IN 1983-1987 FORD MOTOR COMPANY VEHICLES
POWERED BY A 6.9L NAVISTAR INTERNATIONAL HEAVY-DUTY DIESEL ENGINE
AND 1988-1989 MODEL-YEAR FORD MOTOR COMPANY VEHICLES
POWERED BY A 7.3L NAVISTAR INTERNATIONAL HEAVY-DUTY DIESEL ENGINE

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by

Mobile Source Division

State of California
AIR RESOURCES BOARD
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(This report has been reviewed by the staff of the California Air Resources Board and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Air Resources Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.)

SUMMARY

Hypermax Engineering Inc. (Hypermax) of 255 East Route 72, Gilberts, IL 60136, has applied for exemption from the prohibitions in Vehicle Code Section 27156 for their add-on turbocharger kit. The Hypermax turbocharger kit is designed for installation in 1983-1987 model-year Ford Motor Company vehicles powered by a 6.9L Navistar International heavy-duty diesel engine and 1988-1989 Ford Motor Company vehicles with a 7.3L Navistar International heavy-duty diesel engine.

Hypermax has submitted a completed application and all the required information as well as comparative exhaust emissions test data which shows that their kit does not have any adverse effect on the exhaust emissions from the applicable vehicles. Testing performed at the Air Resources Board (ARB) confirmed the results of the tests performed by Hypermax.

The staff recommends that Hypermax be granted an exemption as requested, and that Executive Order D-175-2 be issued.

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EVALUATION OF HYPERMAX ENGINEERING INC.'S ADD-ON TURBOCHARGER KIT FOR
INSTALLATION IN 1983-1987 FORD MOTOR COMPANY VEHICLES POWERED BY A 6.9L
NAVISTAR INTERNATIONAL HEAVY-DUTY DIESEL ENGINE AND 1988-1989 MODEL-YEAR
FORD MOTOR COMPANY VEHICLES POWERED BY A 7.3L NAVISTAR INTERNATIONAL
HEAVY-DUTY DIESEL ENGINE

I. INTRODUCTION

Hypermax Engineering Inc. (Hypermax) of 255 East Route 72, Gilberts, IL 60136, has applied for exemption from the prohibitions in Vehicle Code Section 27156 for their add-on turbocharger kit. The Hypermax turbocharger kit is designed for installation in 1983-1987 model-year Ford Motor Company vehicles powered by a 6.9L Navistar International heavy-duty diesel engine and 1988-1989 model-year Ford Motor Company vehicles with a 7.3L Navistar International heavy-duty diesel engine.

II. CONCLUSIONS

Based on the submitted information and comparative exhaust emissions tests performed at ECS Laboratories Inc. (ESC) and the ARB on a 1988 Ford F-250 heavy-duty diesel truck, the staff concludes that the Hypermax turbocharger kit will not have any adverse effect on exhaust emissions from the vehicles for which the exemption has been requested.

III. RECOMMENDATIONS

The staff recommends that Hypermax be granted an exemption for their turbocharger kit to be used on 1983-1987 model-year Ford Motor Company vehicles powered by a 6.9L Navistar International heavy-duty diesel engine and 1988-1989 model-year Ford Motor Company vehicles powered by a 7.3L Navistar International heavy-duty diesel engine and that Executive Order D-175-2 be issued.

IV. TURBOCHARGER KIT DESCRIPTION AND OPERATION

The purpose of the Hypermax turbocharger system is to increase the power output of the engine by compressing the intake charge to pressures above that of the atmosphere. This increased pressure allows a greater charge density to enter the combustion chamber and increases the volumetric efficiency. The maximum fuel delivery is slightly increased in order to maintain proper air-fuel ratios when the turbocharger is providing positive manifold pressure (boost). The injection pump timing is retarded by two degrees from the original equipment manufacturer (OEM) specifications.

Hypermax offers four turbochargers with their system as follows:

1. AiResearch model 409900-2 with area ratio (A/R) of 0.96;
2. AiResearch model 4658124-5004 with A/R of 1.15;
3. Holset Engineering model H2A7680E/FA019CA2 with A/R of 1.08;
4. Warner-Ishl model RHB7-9700VP28NFBRL552A with A/R of 1.10.

The major components of the system include a turbocharger, custom intake adaptors, 3-1/2" exhaust tubing, brackets, hoses and the hardware necessary to complete the installation.

Maximum positive manifold pressure is limited to 10 psig by the size of the turbine and the compressor. The maximum engine speed is regulated by the OEM fuel injection governor which is not modified by the installation of the kit. Therefore, by controlling maximum engine speed, maximum turbine speed and corresponding boost pressures are also controlled.

No OEM emission controls are removed or disconnected when the turbocharger kit is installed. Positive Crankcase Ventilation (PCV) system is rerouted to the compressor inlet.

Installation instructions, included in every kit, show the kit installer how to properly install the turbocharger system and adjust the maximum fuel delivery properly (see Appendix A).

V. TURBOCHARGER KIT EVALUATION

Evaluation of the Hypermax turbocharger kit was based on the analysis of all submitted information including comparative emissions test data conducted at ECS. The test program used was "Test Program for Add-On Turbocharger Kits for Heavy-Duty Engines" (see Appendix B). The tests were conducted on a 1988 Ford Motor Company F-250 pick-up powered by a 7.3L Navistar International heavy-duty diesel engine. The turbocharger that was used for testing had an area ratio of 1.08. The results of the comparative testing conducted at ECS are shown in Table 1.

Table 1

ECS Laboratory, Inc. Test Results
Steady-State Emissions (g/mi)

| <u>Mode</u> | <u>Configuration</u> | <u>HC</u> | <u>CO</u> | <u>NOx</u> |
|-------------|----------------------|-----------|-----------|------------|
| Idle* | Baseline | 0.037 | 0.134 | 1.439 |
| | Device | 0.067 | 0.129 | 1.194 |
| | Change % | +81 | -4 | -17 |
| 20 mph | Baseline | 0.716 | 2.381 | 6.422 |
| | Device | 0.749 | 1.793 | 6.401 |
| | Change % | +5 | -24 | -0.3 |
| 30 mph | Baseline | 0.396 | 0.877 | 4.873 |
| | Device | 0.436 | 0.701 | 4.621 |
| | Change % | +10 | -20 | -5 |
| 40 mph | Baseline | 0.214 | 0.441 | 4.705 |
| | Device | 0.208 | 0.412 | 4.067 |
| | Change % | -3 | -7 | -14 |
| 50 mph | Baseline | 0.202 | 0.344 | 4.663 |
| | Device | 0.210 | 0.324 | 3.986 |
| | Change % | +4 | -6 | -14 |
| 55 mph | Baseline | 0.258 | 0.379 | 4.912 |
| | Device | 0.234 | 0.330 | 4.456 |
| | Change | -9 | -13 | -9 |

*The idle test results are in grams per minute.

Confirmatory testing was performed at the Air Resources Board Laboratory. Two series of tests were conducted in baseline and device configurations. The average test results are shown in Table 2.

Table 2

Air Resources Board Laboratory Test Results
Steady-State Emissions

| <u>Mode</u> | <u>Configuration</u> | <u>HC(ppm)</u> | <u>CO(%)</u> | <u>NOx(ppm)</u> |
|-------------|----------------------|----------------|--------------|-----------------|
| Idle | Baseline | 11.65 | 0.01 | 468 |
| | Device | 9.10 | 0.01 | 367 |
| | Change % | -22 | 0.0 | -22 |
| 20 mph | Baseline | 21.20 | 0.01 | 283 |
| | Device | 20.50 | 0.01 | 242 |
| | Change % | -3 | 0.0 | -14 |
| 30 mph | Baseline | 21.20 | 0.01 | 332 |
| | Device | 17.70 | 0.01 | 279 |
| | Change % | -17 | 0.0 | -16 |
| 40 mph | Baseline | 21.70 | 0.01 | 437 |
| | Device | 17.50 | 0.01 | 360 |
| | Change % | -19 | 0.0 | -23 |
| 50 mph | Baseline | 22.95 | 0.01 | 562 |
| | Device | 18.80 | 0.01 | 461 |
| | Change % | -18 | 0.01 | -18 |
| 55 mph | Baseline | 28.45 | 0.01 | 539 |
| | Device | 25.25 | 0.01 | 465 |
| | Change % | -11 | 0.0 | -14 |

VI. DISCUSSION

The steady-state test results at ECS indicate a significant increase in HC emissions at idle. Although the increase is significant in percentage, it is not significant in magnitude. However, the confirmatory test results at the ARB showed decrease in emissions at all points. Based on the test data, the staff believes that the installation of the Hypermax Turbocharger Kit will not have significant adverse effects on the exhaust emissions from the vehicles for which exemption is requested.

6.9/7.3L FUEL INJECTION PUMP ADJUSTMENT

The fuel injection pump must be adjusted to realize any performance improvement with the 6.9/7.3L turbocharger package.

By following this simple procedure, the adjustment can be made WITHOUT removing the injection pump from the engine.

1. Locate the triangular-shaped cover plate on the passenger-side of the fuel injection pump - below the throttle lever.
2. Remove (2) 1/4" hex head screws retaining the cover to the pump housing. Place rags under the pump to absorb the fuel that will drain from the pump when the cover is removed.
3. Prepare to rotate the engine by hand using a 15/16" socket, 3" extension and ratchet on the crankshaft damper retaining bolt. Rotate the engine clockwise as viewed from the front to avoid loosening the bolt.
4. By directing a flashlight on to a small mirror and aiming the light onto the hole (exposed by removing the cover plate), a 5/32" hex allen screw will be in view when the injection pump shaft is moved into position by rotating the engine. This 5/32" hex allen screw is the leaf spring or fuel screw. Turning the screw in a clockwise direction increases the fuel delivery.
5. Have an assistant rotate the engine by hand until the 5/32" hex socket screw comes into view. (2) revolution of the engine may be required to bring the hex screw into alignment with the hole.
6. Refer to the BHP VS Fuel Flow Curve attached (upper curves) and decide what power level is desired. **Note: The proposed California setting is 1-1/2 to 2 flats increase in fuel delivery and two degrees retarded injection pump timing.**

The injection pump timing is retarded two degrees by loosening the three mounting stud nuts and rotating the injection pump clockwise two degrees (as viewed from the drive end or front of the engine) this corresponds to 1/16" on the circumference of the mounting flange. If these instructions are not understood by the installer take the vehicle to a qualified diesel injection shop for these adjustments.

Example: If 227 horsepower is desired at 3300 RPM, the 5/32" hex screw must be rotated 180 degrees in a clockwise direction; this corresponds to turning the 5/32" allen wrench (3) flats as indicated by the lower set of fuel curves.

Note:

It is important to obtain a high quality 5/32" allen wrench to avoid damaging the hex drive portion of the screw since rotating the screw will require considerable effort.

7. After rotating the fuel screw to the desired setting, replace the housing cover plate, start the engine and check for fuel leaks.

HYPERMAX ENGINEERING, INC.

*** 1983-89 6.9/7.3L FORD DIESEL PICKUP TRUCK ***

I N S T A L L A T I O N I N S T R U C T I O N S

Time will be saved if these instructions are read PRIOR to installation of turbocharger package.

A. ITEMS TO BE REMOVED:

1. Negative battery cables.
2. Exhaust piping and muffler (DO NOT remove manifolds).
3. Air filter.
4. Crankcase blowby valve and valley cover gromet.
5. Auto trans filler tube and dipstick - take precautions to avoid foreign material entering transmission during installation.
6. Transmission modulator tube.
7. Transmission downshift rod.
8. Pickup Trucks Equipped with Optional Firewall Sound Insulation Package - a 32" W x 21" H section of the firewall insulation MUST BE CUT AWAY at the rear of the engine to provide turbocharger and pipe clearance. Since the turbocharger itself reduces engine combustion noise, the effect of removing the insulation will not be noticeable.

NOTE: Right side refers to passenger-side of vehicle.

B. PRELIMINARY SET-UP:

1. To reduce the possibility of cylinder head gasket leakage, it is advisable to retorque the cylinder head bolts to (6.9L 85 ft. lbs. 7.3L 110 ft. lbs.) after 3,000 miles has been accumulated on the vehicle. Reinstall the rocker arms and posts in their original location with the timing mark on the front pulley at the 11:00 o'clock position as viewed from the front of the engine. Torque the post bolts to 20 ft.-lbs.
2. Provide a 1-5/16" diameter hole in the center of the rear circular impression on the left hand valve cover for installation of a gromet for the crankcase breather. **Note:** A smooth edge is required on this hole, use silicone sealer if hole quality is in question.
3. **1983 model** - remove oil pressure sending unit line from rear of engine leaving flare fitting in block.

1984-89 models - remove oil pressure sending unit and replace it with the combination sending unit turbo lube line assembly fitting. Orientate the fitting such that the sending unit can be reinstalled with its electrical terminal facing rearward.

APPENDIX

Bolt on extension wire to the sending unit with the wire facing down and connect the other end to the wiring harness. Fasten the wire to the combination fitting with a zip tie provided.

4. Install the rubber expansion plug into the rear of the intake manifold. Use "Loctite" on threads.
5. Install the 3/4" I.D. gromet into the opening in the engine valley cover.

C. REROUTING FUEL RETURN LINES, ELECTRICAL & CONTROL CABLES:

1983-85 MODELS

1. Remove the right bank injection nozzle fuel return hose that connects the last injector (No.7) to the main return line fitting.
2. Connect the right and left bank injector returns at the front of the engine with the 22" length of hose provided. Reuse hose clamps.
3. Cap-off the (No. 7) injector and the main return line fitting with the caps removed from (No.1 & No.2) injectors in step 2. Reuse clamps.
4. Reroute the glow plug wiring harness at (No.7) cylinder with the throttle and cruise control cables, causing the glow plug harness to be on top of the cables. Fasten the bundle to the threaded boss at the right rear of the intake manifold inlet with (2) zip ties provided.
5. Remount the vacuum manifold (6") toward passenger-side of engine compartment. Reroute vacuum hoses along with the air conditioning hose. For vehicles without air conditioning, use the (2) mounting zip ties provided and attach just below weather strip on firewall. Take precautions to avoid drilling chips from entering engine during these operations.
6. Straighten the bend next to the frame on the fuel return line so it can be zip tied to the transmission linkage bracket. Also tie the transmission wiring harness to the threaded boss located at the rear of the transmission housing.

1986-89 MODELS

1. Remount the vacuum manifold (6") toward passenger-side of engine compartment. Re-route vacuum hoses along with the air conditioning hose.

For vehicles without air conditioning, use the (2) mounting zip ties provided and attach just below weather strip on firewall. Take precautions to avoid drilling chips from entering engine during these operations.

2. Straighten the bend closest to the frame on the fuel return line so it can be zip tied to the transmission linkage bracket. Also tie the transmission wiring harness to the threaded boss located at the rear of the transmission housing.
3. If equipped with a fuel return hose facing rearward out of the top fitting of injection pump, remove this hose. Turn fitting 180 degree while holding hex adaptor with wrench. NOTE: Use extreme caution when turning fitting. Turning hex adaptor in aluminum pump hosing will result in thread damage. Remove steel fuel return line and cut bend off. Deburr, clean and reinstall fuel line. Connect new hose and hose clamp supplied.
4. Remove throttle and cruise control cables from injection pump and re-route under 3/8" fuel return line at left rear of engine. Fasten both cables to the threaded boss at the right rear of the intake manifold inlet with (2) zip ties provided.
5. Remove (No.2) & (No.7) injection lines at the nozzles. Clean any dirt accumulated around the fitting PRIOR to line removal by flushing with solvent.
6. Remove the plastic fuel return fittings from (No. 2) & (No.7) nozzles by pulling them straight off.
7. Switch (No.2) & (No.7) return fittings - pushing them straight down to install.
8. Reconnect the injection lines.
9. The right and left nozzle banks are now reconnected at the front of the engine.
10. Use the tee and clamps provided to connect the fuel filter bleed return into the line between (No.1) & (No.3) injector.
11. Cap-off the open tube on the brass return line fitting at the rear of the engine with the cap and clamp provided.

D. RELOCATING GLOW PLUG WIRING HARNESS AND RELAY (1987-89 MODELS ONLY):

1. Unplug glow plug harness on passenger side, unbolt relay and ground wire from intake manifold. Disconnect glow plugs and remaining connections. Remove entire glow harness from vehicle with relay intact.

2. Lay harness out on table and reverse position of relay from rear to front of engine, keeping right and left sides of harness the same.
3. **Passenger Side:** Pull oil pressure sending unit wire from front to rear of harness, also pull (three) injection pump connecting wires, fuel heating element connection and temperature sending unit wires from rear to front.

Drivers Side: Pull through the two temperature sending unit connectors from rear to front.
4. The two line clamps which were removed with harness must be drilled for 3/8" diameter bolts.
5. Set glow plug relay mounting plate in position on intake manifold pad with bumper on valve cover. See attached illustration.
6. Lay harness loosely into position on engine.
7. Position harness under (No. 3 and No. 1 cylinder) injection lines. Start from wiring harness connector located on passenger side fender well.
8. Remove throttle cable bracket from intake manifold. Move injection line clamp (right front) toward center of engine to provide clearance for wire bundle to pass to the rear of lifting eye. Use zip tie to hold wire to lifting eye. Reinstall throttle cable bracket - tighten bolts.
9. Position harness below the transmission down shift rod (auto trans only) and also clamp to rear bolt of air cleaner glow plug relay mount. Continue routing under (No. 2 cylinder) injection line to glow plug relay. Wire connections on relay should be facing rear ward.
10. Loop glow plug wires over and below the relay mounting plate and connect to the glow plugs.
11. Connect passenger side glow plugs and remaining oil, fuel, temperature and injection pump terminals.
12. Bolt relay and ground wire to mounting plate with bolts & locknuts supplied.

E. EXHAUST AND TURBINE INLET PIPING:

1. Bolt the turbocharger mounting plate onto the rear face of the right hand cylinder head with (3) 3/8" NC x 1" bolts and lock washers. Center the plate on the bolts to tighten.

2. Install the right and left hand exhaust manifold connecting pipes into the mounting plate inlets. Leave nuts loose enough to adjust for the best pipe joint alignment, then tighten nuts securely. Use "Never Seeze" at all joints.
3. Additional clearance may be required for the exhaust manifold connecting pipes where they pass upward between the firewall and clutch housing. Use an adjustable wrench or piece of pipe to bend the lip formed by the intersection of the floor pan and firewall.
4. Check for clearance between the turbocharger mount and firewall and turbine inlet pipes and floor pan - 1/2" is sufficient. If necessary, pry the firewall away from the turbocharger mount with a length of wood or small bar.

F. TURBOCHARGER HOUSING ORIENTATION:

1. Grease the end of the turbocharger oil drain tube and insert it into the gromet previously installed in the engine valley cover.
2. Loosen the retaining bolts on the turbocharger's exhaust and compressor housings.
3. Install turbocharger, and exhaust gasket onto the mount plate (compressor housing facing left side of the engine) with (4) 3/8" NC stover lock nuts and flat washers. Tighten (4) nuts. This is a TRIAL FIT step.
4. Rotate center housing of turbocharger to align with drain tube.
5. Lightly secure drain tube flange to turbocharger with (2) 3/8" NC x 1" bolts and lock washers.
6. Rotate center housing and lower end of drain tube to permit uniform tube to gromet contact; i.e. - be certain drain tube is not loading one side of gromet heavier than the opposite side.
7. Tighten (2) center section to exhaust housing bolts.
8. Install intake manifold cover with its "O" ring (apply grease to "O" ring). Retain lightly with 3/8 NC x 4" bolt with "O" ring washer and backup washer.
9. Rotate compressor housing to obtain best alignment with connector stub on intake manifold cover - a 3/8 - 1/2" gap will be present.
10. Tighten (2) center section to compressor housing bolts.
11. Remove intake manifold cover.
12. Remove drain tube bolts and remove turbocharger from mounting plate with drain tube in place.

13. Crankcase oil vapors are ingested into the inlet of the turbocharger and may collect in the compressor housing. This oil may leak from the hold-down bolt holes or from between the compressor housing and back-plate. After aligning the compressor housing, put a reference mark on it and the backplate. Remove the compressor housing and apply a thin film of silicone sealer or equivalent product to the mating surfaces of the housing and backplate as well as the bolt threads. Align reference marks.
14. Tighten compressor and exhaust housing bolts and bend over lock tabs.

G. FINAL TURBOCHARGER INSTALLATION:

1. Reinstall turbocharger using "Never Seeze" compound on the exhaust gasket. Center exhaust housing on studs and tighten.
2. Bolt drain tube with its gasket to turbocharger with (2) 3/8 NC x 1" bolts and lock washers.
3. Recheck for optimum drain tube to gromet condition.
4. Tighten turbocharger mounting and drain tube bolts for final time.
5. Remove plastic plug from oil inlet passage at top of turbocharger and fill passage with clean oil.
6. Install turbocharger oil lube fitting using pipe sealer on threads. Fitting should face rearward. **DO NOT** overtighten.
7. Wash inside of oil feed tube (1/4" diameter). Lubricate seal gromets.
8. Install oil line from turbocharger to the flare fitting left in the block on 1983 models, or to the combination fitting previously installed on all other models.
9. Tighten flex fitting nuts until they just bottom on their fittings.

H. INTAKE MANIFOLD COVER INSTALLATION:

1. Slide compressor discharge hose and clamps onto the manifold cover.
2. Install intake manifold cover and hose onto the compressor discharge and onto intake manifold simultaneously.
3. Rotate cover form optimum hose alignment. Be certain cover is bottomed against intake manifold.

4. Install 3/8 NC x 4" bolt with "Loctite" with its "O" ring and back up washer. Tighten only enough to compress "O" ring - Do NOT overtighten! Tighten compressor discharge clamps.

I. TRANSMISSION DOWNSHIFT ROD & AIR CLEANER MOUNT INSTALLATION:

1. Transmission downshift lever on injection pump must be cut to 1/4" radius around the pivot point to provide air cleaner mount clearance. The lever must be removed from the injection pump for this modification.
2. Install downshift rod and check for clearance with turbocharger compressor housing. If interference exists, remove rod and lightly twist each end of the rod in the direction of the interference. Do NOT attempt to bend the downshift rod while installed, as damage will occur to the injection pump lever!
3. Install the air cleaner mount with two (2) 3/8" NC x 1" bolts and lock washers on left side of engine. Use spacer plate under air filter mount for 1983-86 trucks, and glow plug relay mounting plate for 1987-89 trucks. Lightly tighten bolts.
4. Check for clearance between the downshift rod and the air cleaner mount. If interference exists, REMOVE the rod and bend (near the pivot point at the injection pump) back towards the firewall. This will lower the rod.
5. Remove air cleaner mount and install the 3" x 2-3/4" dia. 90 degree rubber elbow onto the air cleaner mount.
6. Install the hose onto the turbocharger air inlet and bolt the air filter mount securely in place above the spacer or glow plug relay mounting plate.
7. Install and tighten hose clamps securing 90 degree rubber elbow to turbocharger and air filter mount.
8. Recheck downshift rod for clearance and connect downshift return spring to down shift rod.
9. Adjust the downshift rod length by setting a .030 gap at the adjusting screw on the injection pump lever with the injection pump at full fuel position and the transmission lever at its full travel.
10. Install crankcase breather gromet into valve cover, screw in 90 degree nylon fitting. Mount crankcase breather valve onto air cleaner mount with original bolts. Use nuts and lockwashers supplied. Install hose.

REMAINING EXHAUST CONNECTION:

1. Install exhaust housing (turbine) discharge pipe between the engine and firewall. Use "Never Seeze" at seal ring and turbine housing joint. Push discharge pipe into turbine housing until it bottoms.
2. Install the (2) 5/16" NC x 3/4" bolts and lock washers through the mounting strap into the tab on the discharge pipe and into the turbocharger mounting plate.
3. Hang 3-1/2" tail pipe from stock hanger.
4. Abandon the existing front and rear muffler hangers. Utilize the ones provided to hang the muffler.
5. Slide the 2-1/2" to 3-1/2" adaptor pipe over the installed muffler connecting pipe. Slip the pipe into the muffler - tighten all clamps.
6. Check for clearance between the floorboard heat shield and exhaust pipe clamp. Shield may be bent if necessary.

K. TRANSMISSION FILLER TUBE:

1. Install the transmission filler tube with "O" ring and secure it with the rear valve cover mounting bolt.
2. Re-install dipstick.
3. Check for clearance between the trans filler tube and the floorboard heat shield. Bend heat shield if necessary.

L. MISCELLANEOUS:

1. Refer to the Fuel Injection Pump Adjustment Instructions to obtain the required setting for California (1-1/2 - 2 flats increase in fuel delivery and two degrees retarded injection pump timing).
2. Install the transmission modulator tube utilizing stock spring clips. Connect the vacuum hose from the injection pump (marked trans) to the modulator tube.
3. Examine the entire installation. Check for interference and contact between wires, tubes and cables with the hot side of the turbocharger.
4. Bend the (2) tabs on the bottom on the stock air cleaner out approximately 1/2". Drill a 1/8" hole in lower front portion of air cleaner for water drain.

NOTE: The lower air filter housings on some pickup trucks incorporate a baffle which may cause a restriction when the filter assembly is mounted. Remove the baffle and stud-guide by drilling out the spotwelds or by sawing.

5. Mount air cleaner. Check that air cleaner base is not touching "hold down" bolt on intake manifold cover. If it touches, clearance air cleaner base. Be sure air cleaner gasket is in 100% contact with mount.
6. 1988 and later pickup trucks with factory cold air ducts require that the hose end of the duct be cut off at the inside radius. Maintain as much straight section of the duct as possible, connect the modified air duct to the air cleaner with the hose provided.
7. The air conditioning hoses may have to be rotated downward - this can be accomplished without breaking system seal.
8. If factory exhaust system is utilized, remove the screens at the tailpipe exit to reduce the system back pressure.
9. Affix the C.A.R.B. exemption label to the top of air cleaner housing or some obvious location in the engine compartment.
10. Reconnect batteries - start engine and check for leaks.

OPERATING NOTES:

1. As with any turbocharger diesel engine, use a brand name Series Three lubricating oil.
2. Injection pump timing should be at the nominal factory specifications. If it has been advanced or combustion noise is unusually loud, have timing checked.
3. The turbocharger supplied with this package has been matched to the vehicle's exhaust system and will not over-boost the engine. **DO NOT** alter the exhaust system to exceed 12 PSIG intake manifold pressure.
4. When the fuel injection pump is adjusted for 1-1/2 - 2 flats (required California setting), a pyrometer must be installed on the vehicle. Limit turbine inlet temperature to 1300 degrees F. A pyrometer tap is provided in the exhaust connector pipe. A boost pressure tap is provided in the intake manifold cover.
5. The 1983 and early 1984 6.9L cylinder head gaskets may develop a slight external coolant leak under prolonged high output operation. This is not due to a combustion leak but rather the result of thermal and mechanical deformation of the cylinder heads at the lower corners.

If this problem occurs, the EARLY GASKETS should be replaced. Installing 1986 CYLINDER HEAD GASKETS will permanently alleviate this problem.

Should a leak develop with the EARLY GASKETS, the addition of a product such as "Prestone" Heavy Duty Cooling System Sealer to the radiator will provide a temporary fix for this problem.

6. Remember to retorque the cylinder head bolts to (6.9L 85 ft./lbs., 7.3L 110 ft./lbs.) approximately 3000 miles after installing new cylinder head gaskets.

HYPERMAX ENGINEERING has accumulated a considerable amount of data during the 6.9/7.3L turbocharger development program. Should you encounter any problems with the installation or operation of the turbocharger system, call a Hypermax Engineering technician for assistance.

LIMITED WARRANTY

All Hypermax Engineering, Inc. non-competition products or merchandise is warranted to be free from defects in material and workmanship, under normal use and service for a period one year (365 days) from date of delivery to the initial end user.

Hypermax Engineering, Inc.'s liability under this warranty is limited to repair or replacement at its option, subject to the provisions set forth herein, of any parts which upon examination by Hypermax Engineering, Inc. are found to be defective. The user shall prepay cost of transportation of defective parts to Hypermax Engineering, Inc. for inspection.

Hypermax Engineering, Inc. shall not have any responsibility under this warranty unless the defect results in a claim arising within the operational periods listed above, the part was properly installed, normally maintained and not subject to misuse, negligence or accident, and the turbocharger, parts, system components and/or accessories were not repaired or altered in such a way that, in the judgement of Hypermax Engineering, Inc. its performance or reliability was adversely affected.

Remedies are expressly limited to the repair or replacement of defective Hypermax Engineering, Inc. products or merchandise as specified herein. Neither Hypermax Engineering, Inc. nor its distributors or dealers have any liability for any other claims including claims for special, indirect, or consequential damages (including but not limited to turbocharger removal, installation, equipment down time, perspective profits or other economic loss) because of any defect. Any claim arising from defects in material or workmanship must be presented in writing to Hypermax Engineering, Inc. within thirty (30) days after the date on which the claim arises, and any action on the claim must be commenced within six (6) months after original Hypermax Engineering, Inc. shipping date.

This system is legal in California and all other states. The HYPERMAX Turbocharger System has been tested for emissions compliance by the state of California and has been issued an exemption under Section 27156 of the California Motor Vehicle Code rendering it legal for sale, installation, and use in the State of California under Executive Order D-175. By satisfying the requirements of the State of California, this system also satisfies the requirements of Memorandum 1A of the United States Environmental Protection Agency and is thereby legal for sale, installation, and use in all 50 states. No modifications to this system as supplied by HYPERMAX ENGINEERING, INC. are permitted.

THIS REPRESENTS THE COMPLETE WARRANTY OFFERED BY HYPERMAX ENGINEERING, INC. AND IS EXPRESSLY IN LIEU OF ANY OTHER WARRANTING, EXPRESSED OR IMPLIED, INCLUDING ANY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. NO PERSON IS AUTHORIZED TO BIND HYPERMAX ENGINEERING, INC. TO ANY WARRANTY OR TERMS NOT SET FORTH HEREIN.

PARTS LIST - 6.9/7.3L FORD DIESEL PICK UP TRUCK

| <u>Line No.</u> | <u>Qty.</u> | <u>Description</u> |
|-----------------|-------------|---|
| 1 | (1) | Turbocharger |
| 2 | (1) | Mount - turbocharger |
| 3 | (1) | Pipe - right exhaust manifold connecting |
| 4 | (1) | Pipe - left exhaust manifold connecting |
| 5 | (1) | Pipe assembly - turbine discharge w/mounting strap & seal ring |
| 6 | (1) | Pipe - muffler connecting |
| 7 | (1) | Pipe - muffler extension (2-1/2 - 3-1/2" diameter) |
| 8 | (1) | Muffler - 3-1/2" diameter inlet and outlet |
| 9 | (1) | Tube assembly - turbocharger oil drain |
| 10 | (1) | Tube assembly - 1/4" diameter turbocharger lube oil supply |
| 11 | (1) | Tube assembly - automatic transmission filler - dipstick |
| 12 | (1) | Tube - automatic transmission modulator |
| 13 | (1) | Rod - automatic transmission downshift |
| 14 | (1) | Mount - air cleaner |
| 15 | (1) | Cover - intake manifold |
| 16 | (1) | Gasket - turbocharger exhaust housing mounting |
| 17 | (1) | Gasket - turbocharger oil drain tube assembly |
| 18 | (1) | Hose - injection nozzle fuel return (3/16" I.D.) 22" long |
| 19 | (1) | Hose - turbocharger compressor discharge (2" I.D.) 2-3/8" long |
| 20 | (1) | Hose - turbocharger compressor inlet (3" I.D. x 2-3/4" I.D.) 90 degrees formed |
| 21 | (1) | Hose - fuel return line (3/8" I.D.) 15" long |

PARTS LIST - FORD PICKUP TRUCK WITH 6.9L DIESEL

| <u>Line No.</u> | <u>Qty.</u> | <u>Description</u> |
|-----------------|-------------|---|
| 22 | (1) | Hose - breather connecting |
| 23 | (1) | Hose - air filter inlet (1988-89 only) |
| 24 | (1) | Plate - glow plug control mounting (1987-89 only) |
| 25 | (1) | Clamp - muffler (2-1/2" diameter) |
| 26 | (1) | Clamp - muffler torctite (2-1/2" diameter) |
| 27 | (4) | Clamp - muffler (3-1/2" diameter) |
| 28 | (2) | Clamp - turbocharger compressor inlet hose |
| 29 | (2) | Clamp - turbocharger compressor discharge |
| 30 | (1) | Clamp - crankcase breather hose |
| 31 | (1) | "O" ring - intake manifold cover (-353) |
| 32 | (1) | "O" ring - automatic transmission dipstick tube (-113) |
| | (1) | Extension wire assembly - oil pressure sender |
| 34 | (1) | Fitting assembly - combination oil pressure sender - turbo lube w/flex fitting |
| 35 | (1) | Fitting - turbo lube oil supply - 1/4" tube x 1/4" NP x 90 degrees flex |
| 36 | (1) | Fitting - 1" x 90 degrees crankcase breather |
| 37 | (1) | Gromet - turbo drain tube valley cover |
| 38 | (1) | Gromet - crankcase breather |
| 39 | (1) | Plug - rubber expansion - intake manifold (1" dia.) |
| 40 | (1) | Plug- 1/4" NP - pyrometer tap - exhaust manifold connecting pipe |
| 41 | (1) | Plug - 1/8" NP - boost pressure tap intake manifold cover |
| 42 | (1) | Plug - air cleaner gromet (1987-89 only) |
| 43 | (4) | Nut - 3/8" NC stover lock |

PARTS LIST - FORD PICKUP TRUCK WITH 6.9L DIESEL

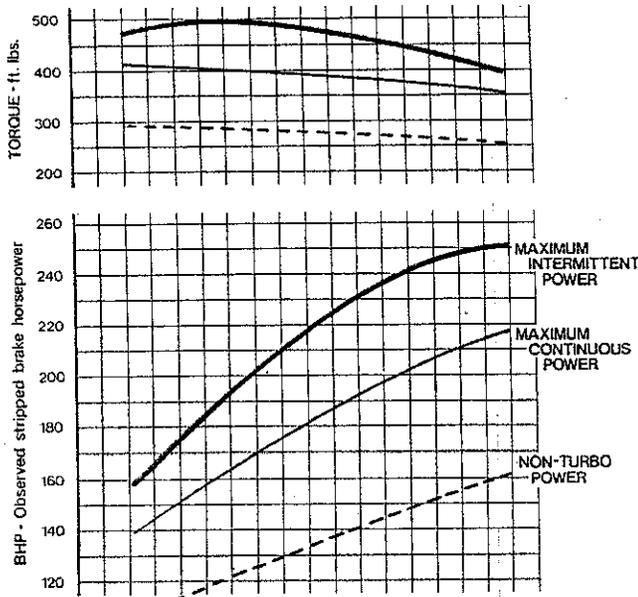
| <u>Line No.</u> | <u>Qty.</u> | <u>Description</u> |
|-----------------|-------------|--|
| 44 | (2) | Lock Nut - 1/4" NC |
| 45 | (2) | Washer - lock 5/16" |
| 46 | (7) | Washer - lock 3/8" |
| 47 | (2) | Washer - flat 7/16" |
| 48 | (1) | Washer - flat 3/8" AN intake manifold cover bolt and "O" ring washer |
| 49 | (6) | Washer - flat 3/8" |
| 50 | (2) | Bolt - 5/16" NC x 3/4" |
| 51 | (5) | Bolt - 3/8" NC x 1" |
| 52 | (2) | Bolt - 3/8" NC x 1-1/4" |
| 53 | (1) | Bolt - 3/8" NC x 4" |
| 54 | (2) | Bolt - 7/16" NC x 1-3/4" |
| | (1) | Tee, plastic fuel line return |
| 56 | (1) | Clamp, fuel line return, (1987 only) |
| 57 | (4) | Clamp, fuel line return |
| 58 | (1) | Cap, fuel return fitting |
| 59 | (6) | Ties - plastic zip |
| 60 | (2) | Tailpipe - w/hook hanger (3-1/2" diameter) |
| 61 | (2) | Hanger - universal type |
| 62 | (1) | Paint - spray can (black) |
| 63 | (1) | Label - C.A.R.B. exemption |
| 65 | (2) | Label - HYPERMAX Turbo Diesel |
| 66 | (1) | Instructions - Pickup Truck Installation including parts list |

Revision Date: 09-26-88

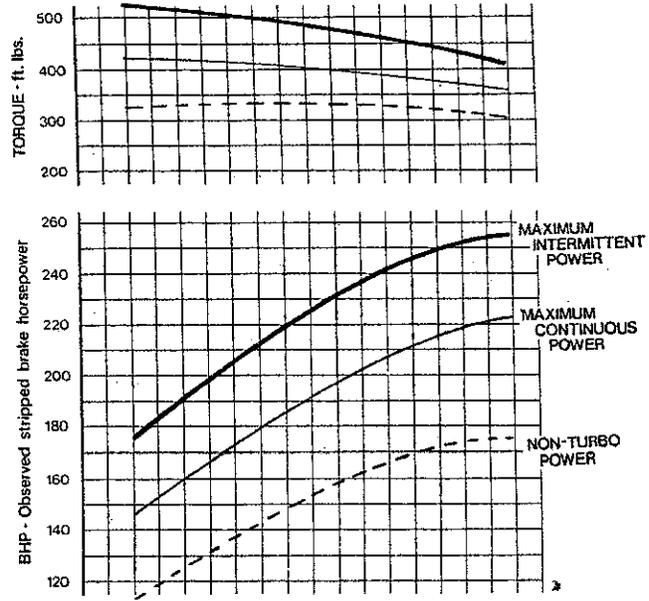
Performance Curves

Hypermax Turbocharged vs. Naturally Aspirated Performance

6.9L Ford/Navistar Diesel Engine



7.3L Ford/Navistar Diesel Engine

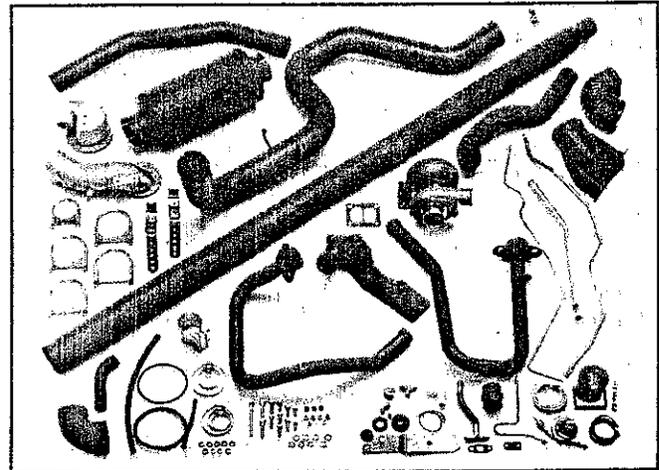


Increased Performance

The dynamometer-developed HYPERMAX 7.3L/6.9L PULSE TURBOCHARGER SYSTEM improves the already impressive performance of the 7.3L/6.9L Ford/Navistar engine. As indicated by the performance curves, up to 50% more power is achieved in turbocharger form. Part throttle vehicle fuel economy is comparable to a naturally aspirated engine. Combustion noise and cold smoke are reduced as well. The HYPERMAX PULSE TURBOCHARGER SYSTEM when used in conjunction with our NEW 3 1/2" DIAMETER muffler and tail pipe provides the lowest exhaust back pressure turbocharger system available on the market today!

Product Support

Hypermax Engineering has developed high output diesel turbocharger and fuel injection systems for championship International Harvester tractor pulling machines since 1973. This background as well as the tremendous amount of dynamometer test data accumulated from our turbocharger development programs enables us to recommend system variations should your application warrant this.



— ALL NECESSARY PARTS AND STEP-BY-STEP INSTRUCTIONS ARE INCLUDED IN THE TURBOCHARGER PACKAGE. (Pictured with boost-pyrometer gauge, 3 1/2" diameter exhaust system, cowl air, and automatic transmission options).



ENGINEERING, INC.

PLEASE REFER TO TSB 88-6-23 FOR REVISED INJECTION PUMP TIMING SPECIFICATION

DATED 3-16-88

Setting Injection Timing — Dynamic Timing

1. Bring engine up to normal operating temperature.

NOTE: When checking or setting dynamic injection timing on the 7.3L engine it is mandatory that the engine be stabilized at normal operating temperature of 89°C-100°C (192°F-212°F). This temperature is needed to ensure proper fuel ignition in the precombustion chambers.

2. Stop engine and install Dynamic Timing Meter, Rotunda 078-00200 or equivalent, by placing magnetic pickup in timing pointer probe hole (Fig. 14). Insert pickup until it almost touches vibration damper.

NOTE: To prevent incorrect readings, ensure that vibration damper is clean and free of foreign debris and rust scale. If required, sand the area to remove rust and apply a light coat of paint to the area.

3. Attach clamp from Timing Meter Adapter Rotunda 078-00201 or equivalent, to the line pressure sensor on No. 1 injector nozzle (F-Series) or No. 4 injector nozzle (E-Series) and connect to timing meter (Fig. 15).

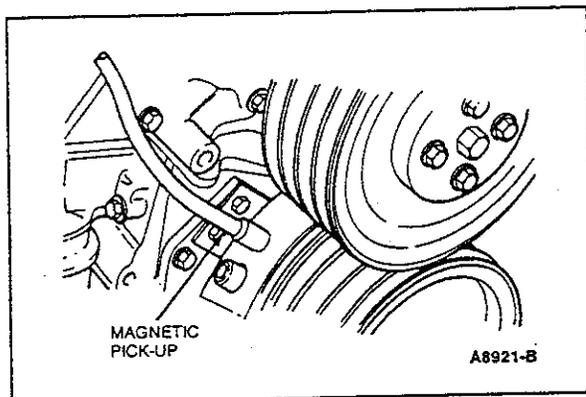


Figure 14 Magnetic Pickup — Dynamic Timing

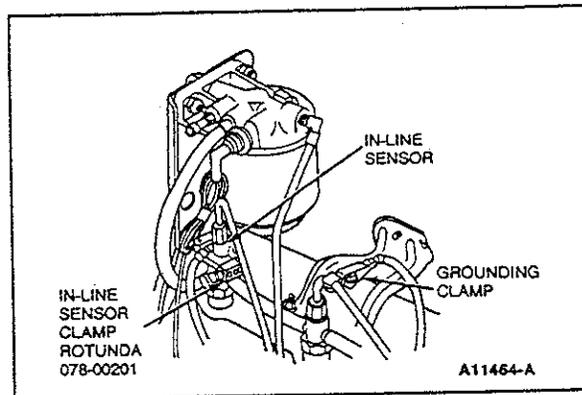


Figure 15 Luminosity Probe — Dynamic Timing

4. Connect dynamic timing meter to battery and dial in minus 20 degrees offset on meter. Disconnect cold start advance solenoid connector from solenoid terminal (Fig. 12).

NOTE: Ensure that all wire leads are located away from the front accessory drive belts.

5. With transmission in NEUTRAL and rear wheels raised off the ground, start engine. Using Throttle Control Tool D87T-9000-E or equivalent, set engine speed to 2000 rpm with no accessory load. Observe injection timing on dynamic timing meter. Injection timing should be 6.5 degrees BTDC at 2000 rpm.

6. Apply battery voltage to cold start advance solenoid terminal to activate it.

NOTE: Activating cold start advance solenoid can result in engine speed increase. Adjust throttle control to attain 2000 rpm, if required.

7. Check timing at 2000 rpm. The timing should be advanced at least 1 degree before the timing obtained in Step 5. If the advance is less than 1 degree, replace fuel injection pump top cover assembly.
8. If dynamic timing is not within ± 2 degrees of specification, adjustment of pump timing is necessary.

6.9L FUEL INJECTION PUMP ADJUSTMENT

The fuel injection pump must be adjusted to realize any performance improvement with the 6.9L turbocharger package.

By following this simple procedure, the adjustment can be made WITHOUT removing the injection pump from the engine.

1. Locate the triangular-shaped cover plate on the passenger-side of the fuel injection pump - below the throttle lever.
2. Remove (2) 1/4" hex head screws retaining the cover to the pump housing. Place rags under the pump to absorb the fuel that will drain from the pump when the cover is removed.
3. Prepare to rotate the engine by hand using a 15/16" socket, 3" extension and ratchet on the crankshaft damper retaining bolt. Rotate the engine clockwise as viewed from the front to avoid loosening the bolt.
4. By directing a flashlight on to a small mirror and aiming the light onto the hole (exposed by removing the cover plate), a 5/32" hex allen screw will be in view when the injection pump shaft is moved into position by rotating the engine. This 5/32" hex allen screw is the leaf spring or fuel screw. Turning the screw in a clockwise direction increases the fuel delivery.
5. Have an assistant rotate the engine by hand until the 5/32" hex socket screw comes into view. (2) revolution of the engine may be required to bring the hex screw into alignment with the hole.
6. Refer to the BHP VS Fuel Flow Curve attached (upper curves) and decide what power level is desired. **Note: The proposed California setting is 1-1/2 to 2 flats increase in fuel delivery.**

Example: If 227 horsepower is desired at 3300 RPM, the 5/32" hex screw must be rotated 180 degrees in a clockwise direction; this corresponds to turning the 5/32" allen wrench (3) flats as indicated by the lower set of fuel curves.

Note: It is important to obtain a high quality 5/32" allen wrench to avoid damaging the hex drive portion of the screw since rotating the screw will require considerable effort.

7. After rotating the fuel screw to the desired setting, replace the housing cover plate, start the engine and check for fuel leaks.

APPENDIX B

Test Program for Add-On Turbocharger Kits for Heavy-Duty Engines

Testing will consist of back-to-back chassis dynamometer tests. Baseline (unmodified configuration) emission results will be compared to turbocharged (modified configuration) emission results on the same vehicle.

A. STEADY STATE TESTS

- 1) Idle
- 2) 20, 30, 40, 50 and 55 mph at 1XRL.

Prior to measuring exhaust emission at any steady state test point, the vehicle's engine temperature shall be stabilized. This is satisfied when engine oil temperature is stabilized as monitored and indicated by a temperature recorder.

If a steady state point is unattainable in the baseline configuration, then the last point at a specified horsepower should be WOT and the speed should be recorded. The test in the turbocharged configuration will be performed at the same speeds and horsepower as the baseline configuration.

Any steady state may be deleted if 1) the steady state exceeds or can be expected to exceed the engine redline or 2) steady state conditions might cause serious damage to vehicle components or dynamometer, or create a hazard for test personnel.

B. STEADY STATE DATA REQUIREMENTS

- 1) CO concentration
- 2) CO₂ concentration
- 3) HC concentration
- 4) NO_x concentration
- 5) engine rpm
- 6) engine oil temperature

C. MISCELLANEOUS

- 1) The same fuel will be used for both the unmodified and modified configurations unless the turbocharger manufacturer's written instructions specify a different fuel for the turbocharged configuration.

- 2) Tire pressure in the drive wheels will be the maximum indicated on the tire sidewall.
- 3) Test vehicles from secondary manufacturers may be tested without a body shell if 1) the cab is intact, 2) the vehicle is legally driveable on the street, 3) the frontal area is identical to the built-up vehicle, 4) the chassis is loaded to a weight simulating loaded vehicle weight. Loaded vehicle weight is defined as the manufacturer's estimated weight of the vehicle in operational status with all standard equipment, the weight fuel at nominal tank capacity, and the weight of optional equipment.