

State of California
AIR RESOURCES BOARD

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

HYPERMAX ENGINEERING INC.
TURBOCHARGER SYSTEM FOR FORD MOTOR COMPANY
HEAVY-DUTY VEHICLES POWERED BY A 6.9 LITER
NAVISTAR INTERNATIONAL HEAVY-DUTY DIESEL ENGINE

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 6.9 liter Navistar International heavy-duty diesel engine. 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" diameter exhaust system.

This exemption shall not apply to any device, apparatus, or mechanism advertised, offered for sale or sold with, or installed on, a motor vehicle prior to or concurrent with transfer to an ultimate purchaser.

This Executive Order is valid provided that installation instructions for this device will not recommend tuning the vehicle to specifications different from those submitted by the device manufacturer.

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 16th day of November, 1987.



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 6.9 LITER NAVISTAR INTERNATIONAL
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HEAVY-DUTY DIESEL ENGINE

by

Mobile Source Division

State of California
AIR RESOURCES BOARD
9528 Telstar Avenue
El Monte, CA 91731

(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 Route 5, Box 178, Sutton Road, Barrington Hills, IL 60010, 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.

Hypermax has submitted a completed application and all the required information as well as comparative exhaust emissions data which shows that their kit does not have an adverse effect on the exhaust emissions from the applicable vehicles.

The staff recommends that Hypermax be granted an exemption for their add-on turbocharger and that Executive Order D-175 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 6.9 LITER NAVISTAR INTERNATIONAL HEAVY-DUTY DIESEL ENGINE

I. INTRODUCTION

Hypermax Engineering Inc. (Hypermax) of Route 5, Box 178, Sutton Road, Barrington Hills, IL 60010, 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.

Hypermax has submitted a completed application and all the required information as well as comparative exhaust emissions test data. The Air Resources Board (ARB) also conducted confirmatory testing.

II. CONCLUSIONS

Based on the submitted information and comparative exhaust emissions tests performed on a 1986 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 that Executive Order D-175 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 increasing the volumetric efficiency of

it 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 providing more oxygen for combustion. The maximum fuel delivery is slightly increased in order to maintain proper air-fuel ratios with the increased air flow from the turbocharger when it is providing positive manifold pressure (boost).

The major components of the system include a 0.81 A/R ratio Airesearch Industrial Division Model No. T04B turbocharger, custom intake adaptors, 3" 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). Turbocharger kit contents are shown in Appendix B.

V. TURBOCHARGER KIT EVALUATION

Evaluation of the Hypermax turbocharger kit included analysis of all submitted information to confirm that it meets the requirements for the

exemption. They also submitted comparative emissions test data conducted at Olson Engineering Inc. The test program used was "Test Program for Add-On Turbocharger Kits for Heavy-Duty Engines" (see Appendix C). The tests were conducted on a 1986 Ford Motor Company F-250 Pick-up powered by a Navistar International heavy-duty diesel engine. The results of the comparative testing conducted at Olson Engineering Inc. are shown in Table 1.

Table 1
Olson Engineering Inc. Laboratory Test Results
Steady State Emissions (g/mi)

<u>Mode</u>	<u>Configuration</u>	<u>HC</u>	<u>CO</u>	<u>NOx</u>
Idle*	Baseline	0.011	0.403	0.669
	Device	0.0154	0.267	0.663
	Change %	+40	-34	-0.9
20 mph	Baseline	0.629	2.661	3.741
	Device	0.417	2.500	4.300
	Change %	-34	-6	+15
30 mph	Baseline	0.334	1.449	2.801
	Device	0.202	1.35	3.022
	Change %	-40	-7	+8
40 mph	Baseline	0.182	0.766	2.602
	Device	0.140	0.717	2.640
	Change %	-23	-6	+1
50 mph	Baseline	0.347	0.708	2.660
	Device	0.231	0.761	2.864
	Change %	-33	+7.4	+7.6
55 mph	Baseline	0.391	0.703	2.878
	Device	0.300	0.745	2.990
	Change %	-23	+6	+4

Confirmatory testing was performed at the Air Resources Board Laboratory.

The results are shown in Table 2.

* The Idle test results are in grams per minute.

Table 2

Air Resources Board Laboratory Test Results
Steady State Emissions (ppm)

<u>Mode</u>	<u>Configuration</u>	<u>HC</u>	<u>CO</u>	<u>NOx</u>
Idle	Baseline	18.6	169	193
	Device	13.4	128	180
	Change %	-28	-24	-7
20 mph	Baseline	18.7	199	148
	Device	15.7	174	164
	Change %	-16	-13	+11
30 mph	Baseline	17.0	158	178
	Device	16.0	130	203
	Change %	-6	-11	+14
40 mph	Baseline	17.6	119	240
	Device	17.1	108	257
	Change %	-3	-9	+7
50 mph	Baseline	23.0	134	246
	Device	21.5	118	267
	Change %	-7	-12	+9
55 mph	Baseline	31.0	136	257
	Device	28.1	126	294
	Change %	-9	-7	+14

Although it was not required for the evaluation of the Hypermax turbocharger system, back-to-back CVS-72 emissions tests with particulate sampling were performed. The purpose of these additional tests was to examine the effect of a turbocharger on the particulate emissions from a diesel vehicle and to examine any differences between the pass/fail determination based on steady-state tests and the pass/fail determination based on transient-type tests. Table 3 shows the CVS-72 emissions test results.

Table 3

CVS-72 Test Results With Particulates (2XRLHP)

	Exhaust Emissions (g/mi)			Particulate Emissions	Fuel Economy
	<u>HC</u>	<u>CO</u>	<u>NOx</u>	<u>g/mi</u>	<u>g/mi</u>
Baseline	0.570	2.028	4.020	0.6436	15.17
Device	0.435	1.695	4.113	0.5507	15.49
Change %	-24	-16	+2	-14	+2

The CVS-72 test results with particulates indicate that the Hypermax turbocharger system does not increase emissions significantly. However, the official steady state test results performed at the ARB indicate significant increases in NOx emissions at three test points (20 mph, 30 mph and 55 mph). Because these increases were above the test variability limits, Hypermax was denied exemption for their turbocharger kit.

Upon further testing conducted at Olson Engineering Inc. Laboratory, Hypermax determined that the significant increases in NOx emissions were caused by a malfunctioning fuel injection pump. They found a loose servo advance adjusting screw on the injection pump light load advance rocker arm. The screw could be easily rotated. Hypermax replaced the fuel injection pump with another pump from a 1986 6.9L heavy-duty diesel engine. Comparative emissions testing was then performed on the vehicle. The results are shown in Table 4.

Table 4

Olson Engineering Inc. Laboratory Test Results
With the Replacement Fuel Injection Pump in PPM

<u>Mode</u>	<u>Configuration</u>	<u>HC</u>	<u>CO</u>	<u>NOx</u>
Idle	Baseline	459.8	1004.3	987.1
	Device	481.6	957.0	867.5
	Change %	+4.7	-4.7	-12.1
20 mph	Baseline	352.1	843.6	948.1
	Device	364.9	808.8	810.9
	Change %	+3.6	-4.1	-14.5
30 mph	Baseline	295.7	583.9	987.3
	Device	287.8	533.2	882.0
	Change %	-3.0	-9.0	-11.0
40 mph	Baseline	240.3	371.1	961.3
	Device	233.2	353.9	893.8
	Change %	-2.9	-4.6	-7.0
50 mph	Baseline	335.0	379.3	823.6
	Device	338.8	346.4	747.3
	Change %	+1.0	-9.0	-9.3
55 mph	Baseline	400.7	369.9	728.6
	Device	339.9	310.7	711.3
	Change %	-15.0	-16.0	-2.0

VI. DISCUSSION

The Olson Engineering Inc. Laboratory test results presented in Table 4 indicate slight increases in HC at three (3) points (idle, 20 mph and 50 mph). However, these increases are within the test variability limits. The NOx and CO emissions are decreased at every test point. The new data generated at Olson Engineering Inc. demonstrates compliance with the requirements for the exemption.

HYPERMAX ENGINEERING, INC.

*** 6.9L 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.

NOTES: It is advisable to retorque the cylinder head bolts to 85 ft./lbs. at this point in the installation.

Right side refers to passenger-side of vehicle.

B. Preliminary Set-Up

1. 1983 model - remove oil pressure sending unit line from rear of engine leaving flare fitting in block.

1984-86 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. 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).

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

B. Preliminary Set-Up (Continued)

4. Pickup Trucks - STANDARD TRANSMISSION ONLY - may require additional clearance for the exhaust pipe into the turbocharger where it passes upward between the firewall and clutch housing. This can be accomplished by grinding or filing the vertical fin or rib on the clutch housing and/or bending the firewall lip with an adjustable wrench.

It is also advisable to grind or file the dust cover bolt boss if the crossover pipe contacts it.

Additional air cleaner to hood clearance can be obtained by cutting the insulation over the air cleaner and denting the protrusion on the hood bracing.

C. Rerouting Fuel Return Lines (83-85 Models), Electrical & Control Cables

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.

Routing Fuel Return Lines - 1986 Models Only

1. Remove (No.2) & (No.7) injection lines at the nozzles. Clean any dirt accumulated around the fitting PRIOR to line removal by flushing with a solvent.
2. Remove the plastic fuel return fittings from (No.2) & (No.7) nozzles by pulling them straight off.
3. Switch (No.2) & (No.7) return fittings - pushing them straight down to install.
4. Reconnect the injection lines.
5. The right and left nozzle banks are now reconnected at the front of the engine.
6. Use the tee and clamps provided to connect the fuel filter bleed return into the line installed in step 5.
7. Cap-off the open tube on the brass return line fitting at the rear of the engine with the cap and clamp provided.

Extra parts provided - for 1986 installations only

- | | | |
|-----|-----------|-------|
| (1) | 1803038C1 | Tee |
| (4) | 1802453C1 | Clamp |
| (1) | 1802452C1 | Cap |

D. Exhaust & Turbine Inlet Piping

1. Bolt the intermediate 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. Bolt the turbocharger mount plate to the front (towards front of engine) of the intermediate mount plate with 3/8 x 1-1/2 bolts and stover lock nuts. Bolts should be installed from the front with (2) 3/8" flat washers on the nut side. Center the plate on bolts and tighten.
3. Slip the short intermediate pipe into the mounting plate inlet. Use "Never Seeze" at all pipe slip joints.
4. Install the pipes connecting the right and left hand exhaust manifolds. Be sure to slip this assembly into the intermediate pipe. Leave nuts loose enough to adjust for the best pipe joint alignment - then tighten nuts securely.
5. 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. Use an adjustable wrench to bend the lip formed by the intersection of the floor pan and firewall.
6. Install and tighten (3) 2-1/4" muffler clamps. Just tighten enough to seal slip joints. Avoid distorting the pipes by overtightening.

E. 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 engine) with (4) 3/8 NC x 1" bolts and flat washers. Tighten (4) bolts. This is a TRIAL FIT step. (Note: mount plate has special locking thread - will lock when bolts are tightened.)
 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.
- Tighten (2) center section to exhaust housing bolts.

Turbocharger Housing Orientation (Continued)

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. Leave 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 backplate. 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.

F. Final Turbocharger Installation

1. Reinstall turbocharger using "Never Seeze" compound on the exhaust gasket. Center exhaust housing on bolts 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.

J 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 and bend cover! Tighten compressor discharge clamps.

H. Transmission Downshift Rod & Air Cleaner Mount Installation

1. 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!
2. Remove the (2) 5/16" bolts on the throttle linkage bracket. Install the air cleaner mount with (2) 5/16 NC x 1" bolts and lock washers in front of the throttle linkage bracket. Lightly tighten bolts.
3. Check for clearance between the downshift rod and the air cleaner mount. If interference exists, REMOVE the rod and bend the pivot point at the injection pump back towards the firewall. This will lower the rod. Also check for clearance at the spring lever on the injection pump. This lever can be clipped with tin snips for additional clearance.
4. Install the 3" x 2-3/4" dia. 90 degree rubber elbow onto the air cleaner mount.
5. Install the hose onto the turbocharger air inlet and bolt the air filter mount securely in place.
6. Install and tighten hose clamps securing 90 degree rubber elbow to turbocharger and air filter mount.
7. Recheck downshift rod for clearance.
8. 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.
9. Remove oil filler cap and install combination crankcase vent/oil filler cap onto oil filler neck at front of engine and push connecting pipe onto fitting in air filter pipe. No hose clamps are used.

I. Remaining Exhaust Connections

1. Install exhaust housing (turbine) discharge pipe between the engine and firewall. Fasten it to the housing with the band clamp provided - lightly tighten clamp so that pipe can be rotated.
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 turbo-charger mounting plate. SECURELY tighten V-band clamp.
3. Cut the expanded end off the side of the muffler connecting pipe.
4. Hang tail pipe from stock hanger, insert short end of 90 degree elbow provided.
5. Abandon the existing front and rear muffler hangers. Utilize the ones provided to hang the muffler.
6. Slide the 2-1/2" to 3" adaptor pipe over the installed muffler connecting pipe. Slip the pipe into the muffler - tighten all clamps.
7. Check for clearance between the floorboard heat shield and exhaust pipe clamp. Shield may be bent if necessary.

J. Transmission Filler Tube

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

K. Miscellaneous

1. Install the transmission modulator tube utilizing stock spring clips. Connect the vacuum hose from the injection pump (marked trans) to the modulator tube.
2. Examine the entire installation. Check for interference and contact between wires, tubes and cables with the hot side of the turbocharger.
3. Bend the (2) tabs on the bottom on the stock air cleaner out approximately 1/2".

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.

4. Mount air cleaner and attach cold air duct.
5. Air conditioning hose may have to be rotated downward - this can be accomplished without breaking system seal.
6. Reconnect batteries - start engine and check for leaks.
7. Refer to the 6.9L Fuel Injection Pump Adjustment Instructions to obtain the required setting for California (1-1/2 - 2 flats increase in fuel delivery)..
8. Affix the C.A.R.B. exemption label to the top of air cleaner housing or some obvious location in the engine compartment.

L. Operating Notes

1. As with any turbocharger diesel engine, use a brand name Series Three lubricating oil. Remove the dipstick when adding oil to the crankcase to prevent an airlock slowing the filling process.
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 3 inch exhaust system and will not overboost 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.

As a precautionary measure should a leak develop with the STOCK GASKETS, the addition of a product such as "Prestone" Heavy Duty Cooling System Sealer to the radiator will provide a simple fix for this problem.
6. Remember to retorque the cylinder head bolts to 85 ft./lbs. approximately 3000 miles after installing new cylinder head gaskets.

HYPERMAX ENGINEERING has accumulated a considerable amount of data during the 6.9L 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 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____. 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 WARRANTIES, 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 - FORD PICKUP TRUCK WITH 6.9L DIESEL

<u>Line No.</u>	<u>Qty.</u>	<u>Description</u>
1	(1)	Turbocharger
2	(1)	Mount - turbocharger
3	(1)	Mount - turbocharger intermediate
4	(2)	Pipe - exhaust manifold connecting
5	(1)	Pipe - short intermediate connecting
6	(1)	Pipe assembly - turbine discharge w/mounting strap
7	(1)	Pipe - muffler connecting
8	(1)	Pipe - muffler extension (2-1/2 - 3" diameter)
9	(1)	Muffler - 3" diameter inlet and outlet
10	(1)	Tube assembly - turbocharger oil drain
	(1)	Tube assembly - 1/4" diameter turbocharger lube oil supply
12	(1)	Tube assembly - automatic transmission filler - dipstick
13	(1)	Tube - automatic transmission modulator
14	(1)	Rod - automatic transmission downshift
15	(1)	Cap assembly - oil fill and vent with gromet and fitting
16	(1)	Mount - air cleaner
17	(1)	Cover - intake manifold
18	(1)	Gasket - turbocharger exhaust housing mounting
19	(1)	Gasket - turbocharger oil drain tube assembly
20	(1)	Injection nozzle fuel return hose (3/16" I.D.) 22" long

PARTS LIST - FORD PICKUP TRUCK WITH 6.9L DIESEL (Continued)

<u>Line No.</u>	<u>Qty.</u>	<u>Description</u>
21	(1)	Hose - crankcase to air filter mount vent (1/2" I.D.) 19" long
22	(1)	Hose - turbocharger compressor discharge (2" I.D.) 2-3/8" long
23	(1)	Hose - turbocharger compressor inlet (3" I.D. x 2-3/4" I.D.) 90 degrees formed
24	(1)	Clamp - turbocharger exhaust "V" band
25	(3)	Clamp - muffler (2-1/4" diameter)
26	(2)	Clamp - muffler (2-1/2" diameter)
27	(4)	Clamp - muffler (3" diameter)
28	(2)	Clamp - turbocharger compressor inlet hose
29	(2)	Clamp - turbocharger compressor discharge
	(1)	"O" ring - intake manifold cover (-353)
31	(1)	"O" ring - automatic transmission dipstick tube (-113)
32	(1)	Fitting assembly - combination oil pressure sender - turbo lube w/flex fitting
33	(1)	Extension wire assembly - oil pressure sender
34	(1)	Fitting - turbo lube oil supply - 1/4" tube x 1/4" NP x 90 degree flex
35	(1)	Fitting - turbo lube oil supply - 1/4" NP flare tee
36	(1)	Gromet - turbo drain tube valley cover
37	(1)	Plug - rubber expansion - intake manifold
38	(1)	Plug - 1/4" NP - pyrometer tap - exhaust manifold connecting pipe
39	(1)	Plug - 1/8" NP - boost pressure tap intake manifold cover
	(2)	Nut - 3/8" NC stover lock

PARTS LIST - FORD PICK-UP TRUCK WITH 6.9L DIESEL (Continued)

<u>Line No.</u>	<u>Qty.</u>	<u>Description</u>
41	(4)	Washer - lock 5/16" diameter
42	(5)	Washer - lock 3/8" diameter
43	(1)	Washer - flat 3/8" - AN - intake manifold cover bolt and "O" ring washer
44	(2)	Washer - flat 3/8"
45	(2)	Bolt - 5/16" NC x 3/4"
46	(2)	Bolt - 5/16" NC x 1"
47	(9)	Bolt - 3/8" NC x 1"
48	(1)	Bolt - 3/8" NC x 4"
49	(2)	Bolt - 3/8" NC x 1-1/2"
50	(2)	Tailpipe - w/hook hanger (3" diameter)
51	(2)	Hanger - universal type
52	(1)	Paint - spray can (black)
53	(6)	Ties - plastic zip
54	(1)	Label - C.A.R.B. exemption
55	(2)	Label - HYPERMAX Turbo Diesel
56	(1)	Instructions - Pickup Truck Installation including parts list

6.9L FUEL INJECTION PUMP ADJUSTMENT INSTRUCTIONS

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 engine clockwise as viewed from the front to avoid loosening the bolt.
 4. By directing a flashlight onto 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. Two (2) revolutions of the engine may be required to bring the hex screw into alignment with the hole.
 6. Rotate the screw clockwise 90 degrees or 1-1/2 to 2 flats on the allen wrench.
- 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, replace the housing cover plate, start the engine, and check for fuel leaks.

Considerations

Rotating the fuel screw (2) flats will raise the fuel delivery and subsequent power from a non-turbocharged setting (N.A. 160 - 170 HP) to maximum turbocharged power of 220 HP. This is only valid for injection pumps set for operation at sea level. Injection pumps set for high altitude (5000 feet above sea level) will require rotating the fuel screw (1) additional flat if the vehicle is operated at sea level the majority of the time.

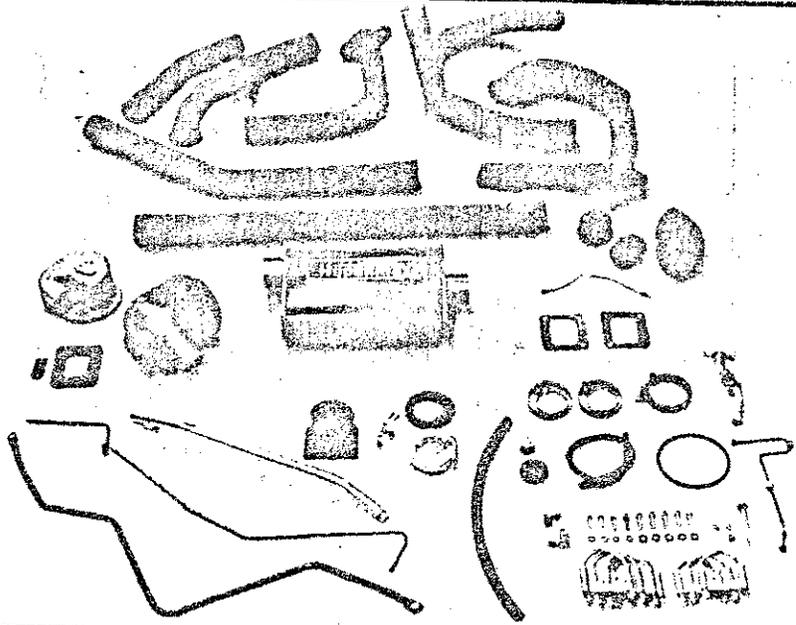
You can identify an altitude set engine by observing the sticker on the valve cover. An altitude engine sticker is punched at 150 HP: a sea level engine is punched at 170 HP.

It should be stressed that operating the engine above 1300 degrees F exhaust temperature (turbine inlet temperature) or in excess of 13 PSIG intake manifold pressure is harmful and should be avoided.

Should either of these limits be exceeded on a grade or prolonged wide open throttle operation, simply back-off on the accelerator pedal or shift to a lower gear.

Certain percentage of injection pumps will not respond to the setting procedure described above. This is due to their being at the high or low end of the maximum fuel delivery specifications as a result of manufacturing tolerances. The low delivery injection pumps yield slightly lower power causing no problems, but the high delivery pumps cause the exhaust temperature to rise rapidly and require frequent accelerator pedal adjustment to keep the exhaust temperature below 1300 degrees F. The setting on high delivery injection pumps should be reduced.

TYPICAL KIT CONTENTS

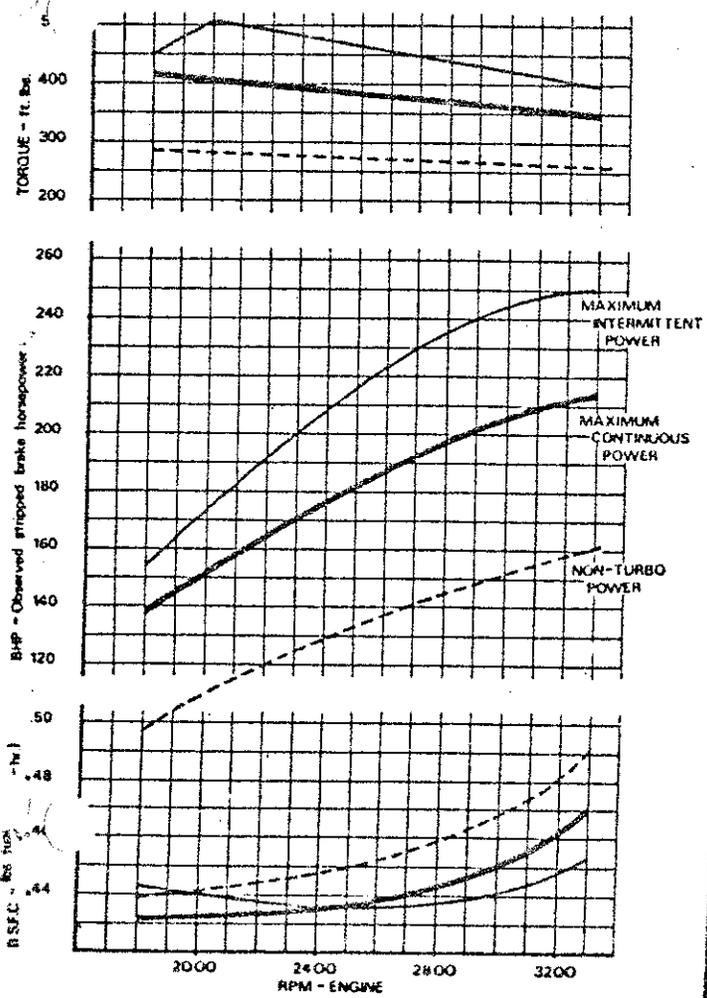


—ALL NECESSARY PARTS AND STEP-BY-STEP INSTRUCTIONS ARE INCLUDED IN THE TURBOCHARGER PACKAGE.

(Pictured with boost-pyrometer gauge and automatic transmission options).

PERFORMANCE CURVES

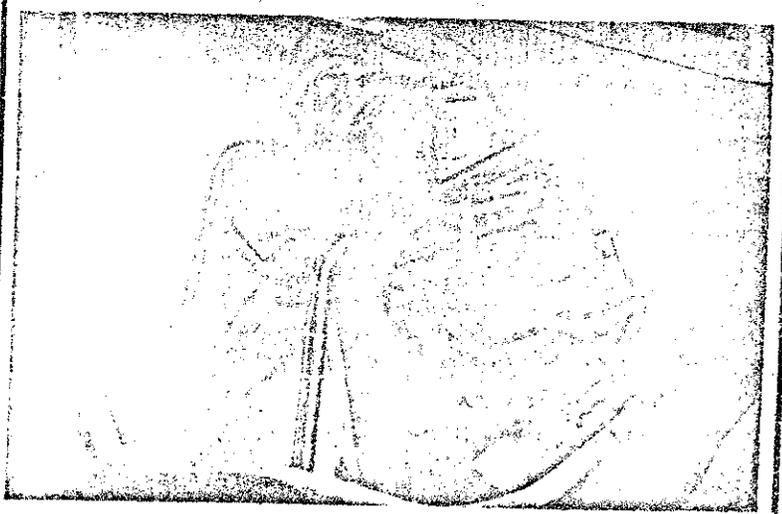
6.9L Ford/IHC Diesel Engine
Hypermax Turbocharged
vs.
Naturally Aspirated Performance



INSTALLATIONS



PICK-UP TRUCK



VAN

- 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.