

State of California
AIR RESOURCES BOARD

EXECUTIVE ORDER D-90
Relating to Exemptions under Section 27156
of the Vehicle Code

RV TURBO, INC.
"RV TURBOCHARGER SYSTEM MODEL NO. 440-1"

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 "RV Turbo-charger System Model 440-1" manufactured by RV Turbo, Inc., 16810 Barker Springs Road, Houston, TX 79707 has been found to not 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 1979 and older heavy duty vehicles equipped with the Chrysler 440 CID engine and M-400 or M-500 chassis.

"RV Turbocharger System Model No. 440-1" kits sold, advertised, or offered for sale in California must contain 0.100" primary carburetor jets, 0.143" secondary carburetor jets, and water injection pressure switches calibrated to inject water beginning at 0-0.5 psig of compressor outlet pressure.

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 "RV TURBOCHARGER SYSTEM MODEL NO. 440-1".

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.

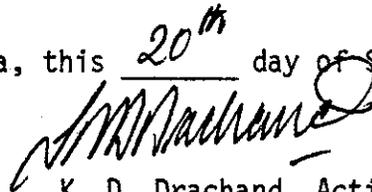
Section 17500 of the Business and Professions Code makes untrue or misleading advertising unlawful, and Section 17534 makes violation punishable as a misdemeanor.

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 20th day of September, 1979.



K. D. Drachand, Acting Chief
Mobile Source Control Division

State of California
AIR RESOURCES BOARD

August, 1979

Staff Report

Evaluation of RV Turbo, Inc.
"RV Turbocharger System Model No. 440-1" for
Exemption from the Prohibitions of Section 27156 of the
Vehicle Code

Introduction

RV Turbo Inc. of 16810 Barker Springs Road, Houston, TX 79707 has submitted an application to exempt its "RV Turbocharger System Model No. 440-1" turbocharger kit from the prohibitions of Section 27156 of the vehicle code. The kit is designed for installation on 1979 and older heavy duty vehicles up to 14500 lb GVW equipped with Chrysler Corp. 440-3, V-8 engines and M-400 or M-500 chassis.

System Description

The purpose of the turbocharger kit is to increase the volumetric efficiency of an engine by increasing the air/fuel charge density in the cylinders. This is accomplished by using a compressor to supercharge the intake manifold. The compressor is driven by a turbine on a common shaft which is, in turn, driven by the heat and pressure of the engine exhaust. Maximum positive manifold pressure is limited to 7 psig by the size of the compressor inlet. No wastegate or other active boost limiting device is used.

The major components of the RV Turbo kit are a carburetor-to-manifold adapter box, Rayjay turbocharger, modified distributor, exhaust manifold, crossover pipe, replacement muffler and water injection unit. These parts are packaged with installation hardware and instructions to be sold as a kit.

The adapter box is mounted on the intake manifold under the carburetor. The turbocharger mounts on the right side of the engine on the replacement exhaust manifold. A crossover pipe routes exhaust from the left cylinder bank to join the right bank exhaust before it enters the turbine.

Water injection is employed to limit detonation during boost. Water is supplied from the motorhome main tank to a solenoid valve. The solenoid is activated by a signal from a pressure sensor located on the adapter box at the compressor outlet. When the solenoid valve opens, water is pumped by motorhome water system pump pressure to a metering orifice in the adapter box on the compressor inlet side.

The original carburetor, a 4V Carter Thermo-Quad, is retained, but a number of modifications are made to adapt it to the turbocharger system. The major changes are the replacement of primary and secondary jets, removal of the metering rod spring to convert rod movement to

mechanical-only operation, alteration of the accelerator pump to convert it from two stage to one stage operation, and recalibration of the secondary air valve tension spring to delay the valve opening. Other alterations can be found in the turbocharger installation instructions in Appendix I.

Test Vehicle

The test vehicle is a Winnebago "Brave" motorhome (VIN 10F45K153461) equipped with a 440 CID heavy duty Chrysler engine and automatic transmission. The gross vehicle weight rating is 12,000 lbs and the curb weight, as tested, was 9960 lbs. The road load horsepower (RLHP) used in the testing was 40 horsepower at 50 mph based on road testing. Frontal area of the vehicle was 75 square feet. The vehicle speedometer reads 48.5 mph at 50 mph true speed. Odometer mileage was 2064 at the beginning of testing.

Test Description

Emission testing consisted solely of back-to-back steady states at the 50 mph road load horsepower (RLHP) and multiples of RLHP. This horsepower was determined by taking the average manifold vacuum and engine rpm on a level track in both directions at 50 mph and duplicating the vacuum and rpm on a dynamometer while measuring horsepower. The test plan is given in Appendix III.

A bench test was performed on the OEM and the modified distributor to determine what changes are made to stock timing specifications.

Time trials were conducted to give an estimate of the turbocharger system's effect on acceleration runs.

Test Results

Emission results of the baseline test and initial device test #1 are given in Appendix III, along with compressor and turbine temperature and pressure measurements. Unfortunately, the device test results were rejected because they indicated some type of carburetor malfunction causing excessive enrichment of the fuel/air mixture. This is seen in Appendix III emission results which show low device NO_x results and high CO compared to the baseline; just the opposite of what would normally be expected. Table III calculations of air/fuel ratio bear out overall richer operation of the turbocharger system.

The carburetor was disassembled, checked and cleaned, but no overt evidence of malfunction was found. It is most probable that a piece of dirt was inadvertently introduced during the applicant's carburetor modifications to cause the enrichment.

A retest was conducted after the applicant was satisfied that the carburetor was operating normally. The air, fuel, and most temperature and pressure measurements were deleted because of testing schedule conflicts. The results of the retest (device test #2) compared to the original baseline are given in Table 1.

Table 1 - Raw Exhaust Concentrations

| Mode | HC, ppm | | CO, % | | NOx, ppm | | Manifold Vacuum, in. Hg | |
|-----------|----------|----------|------------|------------|-----------|------------|-------------------------|-------|
| | base | turbo | base | turbo | base | turbo | base | turbo |
| RLHP-idle | 207 | 115 | 0.26 | 0.42 | 121 | 121 | 16.0 | 17.0 |
| 20 mph | 52 | 35 | 0.36 | 0.20 | 1158 | 355 | 17.0 | 14.0 |
| 40 mph | 35 | 9 | 0.64 | 0.10 | 1158 | 468 | 12.5 | 9.0 |
| 50 mph | 35 | 9 | 0.93 | 0.10 | 1587 | 1074 | 10.5 | 7.0 |
| 55 mph | - | 9 | - | 0.10 | - | 1620 | - | 6.0 |
| 60 mph | 70 | 9 | 2.39 | 0.10 | 1458 | 2084 | 9.0 | 5.0 |
| 2XRL-idle | 160 | 115 | 0.20 | 0.42 | 80 | 100 | 16.5 | 17.0 |
| 20 mph | 52 | 26 | 0.82 | 0.47 | 1158 | 183 | 16.5 | 14.0 |
| 40 mph | 43 | 9 | 0.93 | 0.10 | 1554 | 1130 | 10.0 | 5.0 |
| 50 mph | 43 | 9 | 2.60 | 0.10 | 1620 | 2494 | 5.5 | 1.0 |
| 55 mph | 61 (WOT) | 26 | 8.39 (WOT) | 1.56 | 858 (WOT) | 2494 | 0.5 | 0.2* |
| 60 mph | - | 52 | - | 5.90 | - | 204 | - | 3.4* |
| 3XRL-idle | 151 | 133 | 0.26 | 0.42 | 141 | 100 | 16.5 | 17.0 |
| 20 mph | 61 | 52 | 1.06 | 0.20 | 911 | 355 | 17.5 | 14.0 |
| 40 mph | 35 | 17 | 1.43 | 0.10 | 1755 | 2008 | 10.5 | 1.5 |
| 50 mph | 142 | 26 | 15.74 | 5.90 | 121 | 240 | 3.5 | 3.0* |
| 55 mph | - | 79 | - | 6.22 | - | 225 | - | 4.4* |
| 58 mph | - | 26 (WOT) | - | 0.10 (WOT) | - | 1721 (WOT) | - | 7.0* |

*Positive pressure, psig

Table two contains the results of the bench test on the OEM and modified distributors. All data is in distributor RPM and degrees. Idle distributor RPM is 300.

Table 2 - Distributor Bench Tests

| RPM | Centrifugal Advance | | Vacuum Advance | | |
|------|---------------------|-----------|----------------|-----------|-----------|
| | OEM (deg) | MOD (deg) | VAC (in Hg) | OEM (deg) | MOD (deg) |
| 100 | 0 | 0 | 0 | 0 | 0 |
| 200 | 0 | 0 | 3 | 0 | 0 |
| 300 | 0 | 0 | 6 | 3 | 0 |
| 400 | 0 | +0.5 | 9 | 5 | 3 |
| 500 | 0 | +5.0 | 12 | 7 | 7 |
| 600 | +1.0 | +6.0 | 15 | 9 | 10 |
| 700 | +2.5 | +6.0 | 18 | 10 | 10 |
| 800 | +3.5 | +6.5 | 20 | 10 | 10 |
| 900 | +4.0 | +6.5 | | | |
| 1000 | +4.5 | +6.5 | | | |
| 1100 | +5.0 | +6.5 | | | |
| 1200 | +5.0 | +6.5 | | | |
| 1300 | +6.5 | +6.5 | | | |
| 1400 | +7.0 | +6.5 | | | |
| 1500 | +7.5 | +6.5 | | | |
| 1600 | +8.0 | +6.5 | | | |
| 1700 | +9.0 | +6.5 | | | |
| 1800 | +9.5 | +6.5 | | | |
| 1900 | +9.8 | +6.5 | | | |
| 2000 | +10.0 | +6.5 | | | |

Device installation instructions specify a basic timing setting of 12°-14° BTDC compared to 8° BTDC for the OEM specification.

Table 3 presents the average acceleration times in various modes.

Overall driveability was not adversely affected by the turbocharger installation.

Table 3 - Acceleration Times

| <u>Acceleration Mode, mph</u> | <u>Acceleration Time, sec</u> | |
|-------------------------------|-------------------------------|---------------------|
| | <u>Baseline</u> | <u>Turbocharged</u> |
| 0-20 | 4.6 | 5.2 |
| 0-30 | 7.5 | 7.6 |
| 0-40 | 11.7 | 11.3 |
| 0-50 | 20.0 | 16.1 |
| 0-60 | 28.7 | 23.3 |

Discussion

During an interim run between the first and second set of device emission tests to check carburetor function, it became apparent that the test vehicle was emitting very high levels of NOx at the higher speeds and loads. The applicant's representatives decided at that point to change carburetor jetting to enrichen the air/fuel mixture to provide cylinder cooling for NOx reduction, and supply a separate California version of their kit to contain 0.100" primary jets instead of 0.098", and 0.143" secondaries instead of 0.133". Stock jets are 0.098" and 0.125" respectively.

The data in Table 1 demonstrates that the jet changes serve to eliminate a large part of the NOx problem. Most of the remaining points where the turbocharger NOx levels exceed the baseline can be eliminated by an earlier water injection cut-in. Water injection began at 1.3-1.5 psig in these tests accompanied by substantial reduction in NOx. The applicant has agreed to recalibrate the pressure switch activating the water injection solenoid to supply water at 0-0.5 psig in California kits.

HC and CO emissions for the turbocharged test are lower than for the baseline. High baseline CO at higher loads and speeds and a reduction in NOx in the same modes indicate carburetor power circuit operation (staged metering rods). The carburetor power circuit is curtailed in the turbocharged configuration by removal of the primary metering rod lift spring.

Maximum boost encountered during testing was 7 psig at the highest speed and load tested. This point was 58 mph at WOT at 3XRL horsepower. The baseline vehicle could not attain this point. The increase in horsepower is also shown by the comparison of 0-50 and 0-60 mph acceleration trials in Table 3.

R.V. Turbo has incorporated a warranty statement in their kit to cover the 5 year/50,000 mile emission warranted parts in the event that the original vehicle manufacturer can prove that a part failure is due to turbocharging. A copy of the warranty and warranted parts list is presented in Appendix IV.

Conclusion

The RV Turbo system has demonstrated that it will have no significant adverse effect on emissions when the California version is installed in accordance with the manufacturer's instructions. Timed runs show approximately a 20% decrease in 0-50 and 0-60 mph acceleration time.

Recommendation

The staff recommends that the Board exempt the RV Turbo, Inc., "Turbo-charger System Model No. 440-1" from the prohibitions of VC Section 27156 for 1979 and older heavy duty vehicles equipped with the Chrysler 440-3 engine and M-400 or M-500 Dodge Chassis, with the stipulation that kits sold for use in California be equipped with 0.100" primary and 0.143" secondary jets and water injection system calibrated to open at 0-0.5 psig.