State of California
AIR RESOURCES BOARD

EXECUTIVE ORDER D-430-1
Relating to Exemptions Under Section 27156
of the Vehicle Code

TURBODYNE SYSTEMS, INC.
TURBOPAC 2500
(ELECTRIC SUPERCHARGER)

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 Section 39515 and Section 39516 of the Health and Safety Code and Executive Order G-45-9;

IT IS ORDERED AND RESOLVED: That the installation of the Turbopac 2500, manufactured and marketed by Turbodyne Systems, Inc., 6155 Carpinteria Avenue, Carpinteria, California 93013, has been found not to reduce the effectiveness of the applicable vehicle pollution control systems and, therefore, is exempt from the prohibitions of Section 27156 of the Vehicle Code for heavy-duty diesel vehicles equipped with mechanical fuel injection and no electronic injection timing or electronic throttle delay.

The Turbopac 2500 system includes the following main components: electric supercharger (TurboPac 2500), check valve, wye connection, flex hose, hose clamps, intake plenum pressure switch, throttle switch (or pneumatic throttle switch), master switch, and Turbopac controller.

This Executive Order is valid provided that the installation instructions for the Turbopac 2500 will not recommend tuning the vehicle to specifications different from those of the vehicle manufacturer (i.e., injection timing, throttle delay, etc.).

Changes made to the design or operating conditions of the Turbopac 2500, as exempt by the Air Resources Board, which adversely affect the performance of the vehicle's pollution control system shall invalidate this Executive Order.

Marketing of the Turbopac 2500 using any identification other than that shown in this Executive Order or marketing of the Turbopac 2500 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 the Turbopac 2500 shall not be construed as exemption to sell, offer for sale, or advertise any component of the kit as an individual device.

This Executive Order does not constitute any opinion as to the effect the use of the Turbopac 2500 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 TURBODYNE SYSTEMS' TURBOPAC 2500.

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

Violation of any of the above conditions shall be grounds for revocation of this order. The order may be revoked only after a ten-day written notice of intention to revoke the order, in which period the holder of the order may request in writing a hearing to contest the proposed revocation. If a hearing is requested, it shall be held within ten days of receipt of the request and the order may not be revoked until a determination after hearing that grounds for revocation exist.

Executed at El Monte, California, this 26th day of January 1999.

R. B. Summerfield, Chief
Mobile Source Operations Division

State of California
AIR RESOURCES BOARD

EVALUATION OF THE TURBODYNE SYSTEMS, INC., TURBOPAC 2500 FOR EXEMPTION FROM THE PROHIBITIONS OF VEHICLE CODE SECTION 27156 IN ACCORDANCE WITH SECTION 2222, TITLE 13, OF THE CALIFORNIA CODE OF REGULATIONS

January 1999

by

Mobile Source Operations Division
9528 Telstar Avenue
El Monte, CA 91731

SUMMARY

Turbodyne Systems, Inc. of 6155 Carpinteria Avenue, Carpinteria, California 93013, has applied for an exemption from the prohibitions in Section 27156 of the California Vehicle Code (VC) for their Turbopac 2500 (electric supercharger) designed for heavy-duty diesel vehicles equipped with mechanical fuel injection and no electronic injection timing or electronic throttle delay.

Based on emissions test results, the staff concludes that the Turbopac 2500 will not adversely affect exhaust emissions from vehicles for which the exemption is requested.

The staff recommends that Turbodyne Systems, Inc. be granted an exemption as requested and that Executive Order D-430-1 be issued.

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I. INTRODUCTION

Turbodyne Systems, Inc. of 6155 Carpinteria Avenue, Carpinteria, California 93013, has applied for an exemption from the prohibitions in Section 27156 of the California Vehicle Code (VC) for their Turbopac 2500 (electric supercharger) designed for heavy-duty diesel vehicles equipped with mechanical fuel injection and no electronic injection timing or electronic throttle delay.

II. CONCLUSIONS

Based on comparative emissions testing performed with and without the Turbopac 2500 installed, the staff concludes that Turbodyne Systems, Inc.'s Turbopac 2500 will not adversely affect exhaust emissions from the vehicles for which the exemption is requested.

III. RECOMMENDATION

The staff recommends that Turbodyne Systems, Inc. be granted an exemption for their Turbopac 2500 for installation on those heavy-duty diesel vehicles equipped with mechanical fuel injection and no electronic injection timing or electronic throttle delay. The staff also recommends that Executive Order D-430-1 be issued.

IV. TURBOPAC 2500 DESCRIPTION

The Turbopac 2500 system consists of an electric supercharger (Turbopac 2500), check valve, wye connection, flex hose, hose clamps, intake plenum pressure switch, throttle switch (mechanical or pneumatic), master switch, and Turbopac controller. The system operates in conjunction with the original equipment manufacturer's (OEM) mechanical fuel injection system and emission control system already certified with the stock engine.

The purpose of installing the Turbopac on an engine is to increase its volumetric efficiency and power output at particular engine loads and throttle openings. With a conventional turbocharged engine, boost is minimal at low engine speed and cruise conditions. The boost levels in a stock

turbocharger system often lag behind actual demand by the driver. The Turbopac 2500 is designed to supply instantaneous boost (relative to stock turbochargers) during transient driving conditions beginning at low engine speed and/or boost levels in order to optimize the power output until the stock turbocharger reaches normal boost levels. At 8 psi of boost, the Turbopac shuts off and the stock turbocharger continues to produce boost as normal.

In diesel vehicles, high particulate and hydrocarbon emissions occur at transitional periods from low boost levels to high boost levels (low to high engine load). At heavy engine loads and increased throttle openings, the manifold pressure is increased by the stock turbocharger allowing more air and fuel to enter the engine, resulting in a higher power output, but there is a lag. With the Turbopac 2500, as soon as the engine speed/load is increased, the Turbopac 2500 is activated, supplying boost to the engine. The available boost increases the available power during the initial moments of transient driving conditions. When the stock turbocharger begins to reach normal boost levels (8 psi and above), the increased manifold air pressure is sensed by the Turbopac 2500 intake plenum pressure switch and the Turbopac is deactivated. By this time, the engine and stock turbocharger are operating at normal speed and efficiency. The Turbopac is driven utilizing an electric motor and can be shut off at anytime by turning off the master control switch.

The installation of the Turbopac 2500 does not require any major modifications to the stock engine, except for the insertion of the check valve and wye connection to the air intake piping. The intake plenum pressure switch is installed between the stock turbocharger and the engine intake manifold. The throttle switch is mounted to the governor, or when necessary, a pneumatic throttle switch is utilized. All other Turbopac connections are electrical.

V. DISCUSSION OF THE TURBOPAC 2500

Because of the universal nature of this exemption, four heavy-duty vehicles were tested for the evaluation of the Turbopac 2500. The four vehicles tested were selected based on representativeness of the in-use fleet. The four test vehicles were equipped with the following engines:

Make	Model-Year	Engine Family	Engine Family Group
Caterpillar	1987	HCT0638FPA5	3306
Cummins	1990	LCE0611FABX	L10
Detroit Diesel (GM)	1984	EGM0426WF8	6L71TA
Navistar	1988	JNV0466FPA8	DTA466

The vehicles were tested on a chassis dynamometer at the facility of California Truck Testing Services. Testing consisted of two EPA Heavy-Duty Urban Dynamometer Driving Schedules in the baseline and modified configurations. For each configuration, variation between tests was monitored by the ARB, in the case of unacceptably high variation between tests, a third test would have to be performed, and the results averaged. For the four vehicles, only one variation of 18% occurred for NMHC for one vehicle. The remaining pertinent test results remained near or below 10% variability within each configuration, so only two tests per configuration were required for all four vehicles. The ARB did not perform testing to confirm the test results submitted by the applicant.

Results from comparative testing conducted at California Truck Testing Services between the stock and modified configurations for all four vehicles yielded average decreases in nonmethane hydrocarbons (NMHC), carbon monoxide (CO), & particulate matter (PM), and a small increase in oxides of nitrogen (NOx). The increase in NOx was within the permitted 10% of baseline. The test results in grams per mile were as follows:

		NMHC	CO	NOx	PM
Caterpillar					
	Baseline	0.250	4.608	11.827	0.750
	Modified	0.266	2.982	12.123	0.424
	% Change	+7	-35	+3	-43
Cummins					
	Baseline	0.861	9.973	13.397	1.079
	Modified	0.851	8.068	13.732	0.812
	% Change	-1	-19	+3	-25
Detroit Diesel (GM)					
	Baseline	0.542	7.662	12.014	1.237
	Modified	0.405	4.035	12.767	1.129
	% Change	-25	-47	+6	-9
Navistar					
	Baseline	0.318	3.330	8.341	0.498
	Modified	0.332	2.911	8.525	0.502
	% Change	+4	-13	+2	+1
% of Baseline Limit		+10	+15	+10	+15

Therefore, based on the test results, the staff concludes that the installation of the Turbopac 2500 will not have an adverse effect on exhaust emissions on California-certified engines.

Turbodyne Systems, Inc. has submitted all the required information and fulfilled the requirements for an exemption.