

State of California
AIR RESOURCES BOARD

EXECUTIVE ORDER D-386
Relating to Exemptions Under Section 27156
of the Vehicle Code

AIRESOURCE TECHNOLOGIES, INC.
C855 REPLACEMENT TURBOCHARGER

Pursuant to the authority vested in the Air Resources Board (ARB) 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-45-9;

IT IS ORDERED AND RESOLVED: That the installation of the C855 Replacement Turbocharger, manufactured by AiResource Technologies, Inc. of 955 Jones Road, Yuba City, California 95991, has been found not to reduce the effectiveness of the applicable vehicle pollution control system, and therefore, the C855 Replacement Turbocharger is exempt from the prohibitions of Section 27156 of the California Vehicle Code for installation on 1979 and older model-year Cummins Engine Company, Inc. 855 cubic inch displacement, 6-cylinder, turbocharged and aftercooled, diesel-powered engines.

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

Changes made to the design or operating conditions of the device, as exempt by the ARB, which adversely affect the performance of a vehicle's pollution control system shall invalidate this Executive Order.

Marketing of the device using an identification other than that shown in this Executive Order or marketing of the device for an application other than those listed in this Executive Order shall be prohibited unless prior approval is obtained from the ARB. Exemption of the device 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 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 AIRESOURCE TECHNOLOGIES, INC.'S C855 REPLACEMENT TURBOCHARGER.

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.

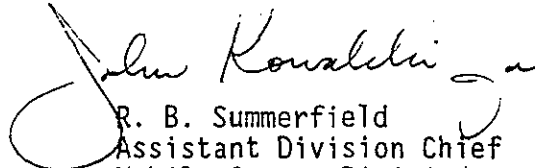
Violation of any of the above conditions shall be grounds for revocation of this Executive Order. The Executive Order may be revoked only after a ten-

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day written notice of intention to revoke the Executive Order, in which period the holder of the Executive 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 Executive Order may not be revoked until a determination after the hearing that grounds for revocation exist.

Executed at El Monte, California, this 10th day of April 1996.


R. B. Summerfield
Assistant Division Chief
Mobile Source Division

State of California
AIR RESOURCES BOARD

EVALUATION OF AIRESOURCE TECHNOLOGIES, INC.'S
C855 REPLACEMENT TURBOCHARGER
FOR EXEMPTION FROM THE PROHIBITIONS OF VEHICLE CODE
SECTION 27156 IN ACCORDANCE WITH SECTION 2222, TITLE 13 OF THE
CALIFORNIA CODE OF REGULATIONS

April 1996

State of California
AIR RESOURCES BOARD

EVALUATION OF AIRESOURCE TECHNOLOGIES, INC.'S
C855 REPLACEMENT TURBOCHARGER
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by

Mobile Source Division

State of California
Air Resources Board
9528 Telstar Avenue
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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 the mention of trade names or commercial products constitute endorsement or recommendation for use.)

SUMMARY

AiResource Technologies, Inc. of 955 Jones Road, Yuba City, California 95991 has applied for an exemption from the prohibitions of Section 27156 of the California Vehicle Code for their C855 Replacement Turbocharger. The C855 Replacement Turbocharger is designed for installation on 1979 and older model-year Cummins Engine Company, Inc. 855 cubic inch displacement, 6-cylinder, turbocharged and aftercooled, diesel-powered engines.

Engineering evaluation based on the functional test data obtained from steady-state chassis dynamometer testing show that the C855 Replacement Turbocharger meets the requirements of Section 27156 of the California Vehicle Code and Section 2222, Title 13 of the California Code of Regulations and will not adversely affect the emissions from those engines for which the exemption is requested.

The staff recommends that AiResource Technologies, Inc. be granted an exemption as requested and that Executive Order No. D-386 be issued.

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I. INTRODUCTION

AiResource Technologies, Inc. (ATI) of 955 Jones Road, Yuba City, California 95991 has applied for an exemption from the prohibitions of Section 27156 of the California Vehicle Code for their C855 Replacement Turbocharger for installation on 1979 and older model-year Cummins Engine Company, Inc. (Cummins) 855 cubic inch displacement (CID), 6-cylinder, turbocharged and aftercooled, diesel-powered engines. ATI has submitted functional test data obtained from steady-state chassis dynamometer testing conducted on a 1979 model-year California-certified Cummins 855 CID engine.

II. CONCLUSION

Staff conducted an engineering evaluation, and based on the test data submitted by ATI, the staff concludes that the C855 Replacement Turbocharger does not adversely affect the exhaust emissions from those engines for which the exemption is requested.

III. RECOMMENDATION

The staff recommends that ATI be granted an exemption as requested, permitting advertisement, sale and installation of their C855 Replacement Turbocharger on 1979 and older model-year Cummins 855 CID 6-cylinder, turbocharged and aftercooled, diesel-powered engines, and that Executive Order No. D-386 be issued.

IV. DEVICE DESCRIPTION AND OPERATION

The C855 Replacement Turbocharger has been designed to replace the Original Equipment Manufacturer (OEM) Cummins ST50 turbocharger used on 1979 and older model-year Cummins 855 CID 6-cylinder engines. As does the OEM Cummins ST50 turbocharger, the C855 Replacement Turbocharger increases the engine power output by pressurizing the intake air, thereby increasing the density of the charge air from a given engine displacement. The C855 Replacement Turbocharger is identical to the OEM turbocharger with the following exceptions. The dimensions of the C855 Replacement Turbocharger turbine housing have been changed from those of the OEM turbocharger. The turbine nozzle area (A) and the distance from the center of the turbine wheel to the centroid of area A (R) of the replacement turbocharger have been reduced. The overall effect of these changes is a decreased A/R ratio. Also, the blade-tip height of the C855 Replacement Turbocharger compressor impeller has been increased with all other dimensions of the compressor remaining the same. There are no other changes from the OEM turbocharger, and the replacement turbocharger requires no modification to the OEM system.

V. DEVICE EVALUATION AND DISCUSSION

ATI has submitted results of testing conducted at DynoData, Inc. located in Stockton, California. The test engine used was a California-certified 1979 model-year Cummins 855 CID 6-cylinder engine. The emission levels of oxides of nitrogen (NOx) were measured over a 13-mode steady-state test using a chassis dynamometer with the vehicle in the original configuration and after the installation of the C855 Replacement Turbocharger. The NOx emission levels were measured in parts per million and were calculated in grams per brake-horsepower-hour (g/bhp-hr). The NOx emission levels weighted over the 13 modes before and after the modification were 8.59 g/bhp-hr and 8.51 g/bhp-hr, respectively. Smoke opacity levels

were also measured in accordance with the Society of Automotive Engineers J1243 snap-idle test procedure. Other parameters measured during the test were the boost pressure, compressor discharge temperature, and exhaust gas temperature. Since the replacement turbocharger was tested using a non-standard test procedure, the staff conducted an engineering evaluation of the C855 Replacement Turbocharger to determine its emissions impact on the applicable engines.

Two major components of a turbocharger are the turbine, which converts energy of the engine exhaust gases to shaft power, and the compressor, which increases the pressure of the air or air-fuel mixture. For a turbocharger with a vaneless turbine housing, as is used in both the OEM and the replacement turbocharger, the amount of gas flow into the turbine is determined by the A/R ratio. In basic operation of a turbocharger, a smaller A/R ratio will produce a faster running turbocharger which increases the boost pressure. With increased boost pressure, the compressor discharge temperature also rises. However, the additional air supplied by the faster turbocharger may reduce the engine operating temperature.

In general, the compressor is more sensitive to flow changes than the turbine, and there are many compressor-impeller variations. Similar to the backward-curved compressor impeller where the blades curve backward from the direction of rotation, the increase in the blade-tip height increases compressor efficiency (reduction in heat gain or loss) due to minimal recirculation from the impeller discharge back to the blades. It also decreases strength (reduction in gas velocity) because the centrifugal force at high speed tends to bend the blades at their roots. This, in turn, produces lower boost pressure and lower compressor discharge temperature.

Attachments 1 and 2 compare the boost pressure and compressor and exhaust gas temperatures for the two turbochargers at the maximum observed

torque at the rated 2800 revolutions per minute (rpm) and at the intermediate 1700 rpm engine speeds, respectively. For the replacement turbocharger with the lower A/R ratio, the test results show increases in boost pressure and compressor discharge temperature and a decrease in exhaust gas temperature. These trends are consistent with the operation of a turbocharger and are observed for the duration of the chassis dynamometer testing.

The power output of a diesel engine is a function of the fuel-injection and not of the intake manifold pressure as in gasoline engines. Since recalibration of the fuel injection system is not required for the use of the replacement turbocharger, the increased boost pressure will not have a significant effect on power output. The difference in the compressor discharge temperatures for the two turbochargers may be attributed to the increased boost pressure but is not significant enough to affect the operation of the engine or its exhaust emissions. The increased air supply generated by higher boost may have caused the decrease in the exhaust gas temperature which in turn may have slightly decreased the NOx emissions. This change in NOx emissions is minimal and is not expected to affect the particulate matter emission levels. This is demonstrated by the measured smoke opacity levels. As shown in the two attachments, the opacity levels decreased slightly with the replacement turbocharger and remained well below the 40 percent opacity standard. The modification made to the compressor blades seemed to have little overall effect on the operating parameters of the replacement turbocharger.

These results indicate that the replacement turbocharger operates within the natural characteristics of a turbocharger, and the staff believes that similar effects will be exhibited if the C855 Replacement Turbocharger is used on the applicable engines. Therefore, the staff concludes that the C855 Replacement Turbocharger will not have any adverse effect on exhaust

emissions of the engines for which the exemption is requested.

ATI has submitted all the required information and has fulfilled the requirements for an exemption.