

State of California
AIR RESOURCES BOARD

EXECUTIVE ORDER D-244-2
Relating to Exemptions Under Section 27156
of the Vehicle Code

JIM WOLF RACING
P.O.P. INFINITI Q45 NITROUS OXIDE SYSTEM, KIT #S Q45CAOBNOS, Q45CAOANOS,
Q45FAOBNOS, & Q45FAOANOS

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-45-5;

IT IS ORDERED AND RESOLVED: That the installation of the P.O.P. Infiniti Q45 Nitrous Oxide System, kit #s Q45CAOBNOS, Q45CAOANOS, Q45FAOBNOS, & Q45FAOANOS manufactured by Jim Wolf Racing 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 installation on 1990-1992 Infiniti Q45s powered by the 4.5 liter V-8 gasoline engine.

This Executive Order is valid provided that installation instructions for the P.O.P. Infiniti Q45 Nitrous Oxide System, kit #s Q45CAOBNOS, Q45CAOANOS, Q45FAOBNOS, & Q45FAOANOS 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 ARB, 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 ARB.

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

This Executive Order is granted based on results from emissions tests conducted in accordance with Cold-Start CVS-75 Federal Test Procedure. However, the ARB finds that reasonable grounds exist to believe that use of the P.O.P. Infiniti Q45 Nitrous Oxide System, kit #s Q45CAOBNOS, Q45CAOANOS, Q45FAOBNOS, & Q45FAOANOS may adversely affects emissions of motor vehicles when operating under conditions outside the parameters of the previously prescribed test procedures. Accordingly, the ARB reserves the right to conduct additional emission tests, in the future, as such tests are developed, that will more adequately measure emissions from all cycle phases. If such test results demonstrate that the P.O.P. Infiniti Q45 Nitrous Oxide System, kit #s Q45CAOBNOS, Q45CAOANOS, Q45FAOBNOS, & Q45FAOANOS adversely affects emissions during off-cycle conditions (defined as those conditions which are beyond the parameters of the Cold-Start CVS-75 Federal Test Procedure), this Executive Order shall be effectively rescinded as of the date the test results are validated. Further, if such test

results or other evidence provides the ARB with reason to suspect that the P.O.P. infiniti Q45 Nitrous Oxide System, kit #s Q45CAOBNOS, Q45CAOANOS, Q45FAOBNOS, & Q45FAOANOS will affect the durability of the emission control system, Jim Wolf Racing shall be required to submit durability data to show that the durability of the vehicle emission control system is not, in fact, affected and/or that the add-on or modified part demonstrates adequate durability.

In addition to the foregoing, the ARB reserves the right in the future to review this Executive Order and the exemption provided herein to assure that the exempted add-on or modified part continues to meet the standards and procedures of Title 13, California Code of Regulations, Section 2222, et seq.

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 JIM WOLF RACING'S P.O.P. INFINITI Q45 NITROUS OXIDE SYSTEM, KIT #s Q45CAOBNOS, Q45CAOANOS, Q45FAOBNOS, & Q45FAOANOS.

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.

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

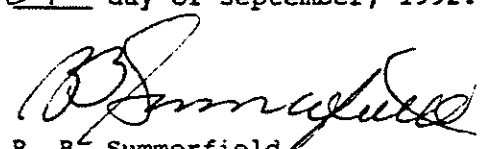
Section 43644 of the Health and Safety Code provides as follows:

"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 may result in its rescission or submission to the Attorney General of California for such action as he deems advisable.

The Bureau of Automotive Repair will be notified by copy of this order.

Executed at El Monte, California, this 24th day of September, 1992.


R. B. Summerfield
Assistant Division Chief
Mobile Source Division

State of California
AIR RESOURCES BOARD

EVALUATION OF JIM WOLF RACING
P.O.P. INFINITI Q45 NITROUS OXIDE SYSTEM FOR EXEMPTION FROM THE
PROHIBITIONS OF VEHICLE CODE SECTION 27156 IN ACCORDANCE WITH
SECTION 2222, TITLE 13, OF THE CALIFORNIA CODE OF REGULATIONS

September 1992

State of California
AIR RESOURCES BOARD

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SECTION 2222, TITLE 13, OF THE CALIFORNIA CODE OF REGULATIONS

by

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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

Jim Wolf Racing has applied for an exemption from the prohibitions of Vehicle Code Section 27156 for their P.O.P. Q45 Nitrous Oxide System (NOS), kit #s Q45CAOBNOS, Q45CAOANOS, & Q45FAOANOS for installation on 1990-1992 Infiniti Q45s equipped with 4.5L engine. Jim Wolf Racing has submitted a completed application and all the required information, as well as exhaust catalyst temperature data.

Based on the submitted information and an engineering evaluation, the staff concludes that the installation of the P.O.P. Q45 NOS, kit #s Q45CAOBNOS, Q45CAOANOS, & Q45FAOANOS will not adversely affect exhaust emissions on the affected vehicles when tested in accordance with the Cold Start CVS-75 Federal Test Procedure.

The staff recommends Jim Wolf Racing be granted an exemption as requested and that Executive Order D-244-2 be issued.

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I. INTRODUCTION

Jim Wolf Racing of 537 West Main Street, El Cajon, California 92020, has applied for an exemption from the prohibitions of Vehicle Code Section 27156 for their P.O.P. Q45 Nitrous Oxide System (NOS), kit #s Q45CAOBNS, Q45CAOANOS, & Q45FAOANOS for installation on 1990-1992 Infiniti Q45s equipped with a 4.5L V-8 gasoline engine.

Jim Wolf Racing has submitted a completed application and all the required information, as well as exhaust catalysts temperature data.

II. CONCLUSIONS

Based on the submitted information and an engineering evaluation, the staff concludes that the installation of the P.O.P. Infiniti Q45 NOS, kit #s Q45CAOBNS, Q45CAOANOS, & Q45FAOANOS will not adversely affect exhaust emissions from vehicles for which the exemption is requested when tested in accordance with the Cold Start CVS-75 Federal Test Procedure.

III. RECOMMENDATION

The staff recommends that Jim Wolf Racing be granted an exemption as requested and that Executive Order D-244-2 be issued.

IV. P.O.P. Q45 NITROUS OXIDE SYSTEM DESCRIPTION

The P.O.P. Q45 NOS is specifically designed for installation on 1990-1992 Infiniti Q45s that are equipped with a 4.5L V-8 gasoline engine. The kit uses the automotive grade chemical nitrous oxide to enhance the performance of the vehicle at wide open throttle (WOT) only.

The P.O.P. Infiniti Q45 Nitrous Oxide kit can be separated into three main components: electrical, hardware, and gas. The electrical modifications include the following components:

- PROM:** The PROM is modified to include an expansion of the fuel table at full throttle operation and the addition of support hardware to detect a full throttle mode. The expansion of the fuel table is designed to accommodate and differentiate the use of nitrous oxide during full throttle operation. The support hardware buffers the signals that the PROM monitors, allowing no distortion to the input and output signals. When full throttle is detected, a signal is sent to the power relay.
- Power Relay:** The power relay is an electronic switch which monitors the signals from the arming switch and the PROM. The power relay will switch on the supply solenoid if the vehicle is at full throttle and the arming switch is on.
- Supply Solenoid:** The supply solenoid is the valve that controls the flow of nitrous.

The hardware components of the nitrous oxide system can be separated into two categories, primary and support:

- Primary:** The primary components include the supply bottle, fuel pump, and injector. The supply bottle weighs 19 lbs. and can hold a maximum of 15 lbs. of nitrous oxide which translates to a total bottle weighing 34 lbs. An emergency pressure relief valve, vented away from the passenger compartment, is incorporated with the supply bottle. A #42 flare jet is used on the kits to deliver the nitrous oxide.
- Support:** Support hardware includes reinforced tubing, associated brackets, and a bottle heater. The reinforced tubing runs from the supply bottle to the flow solenoids and then to the nitrous oxide injector. Typical brackets included in the kit are those used to support the bottle and flow solenoid. A bottle heater is installed around the supply bottle to maintain a 75 to 85 degrees Fahrenheit when required.

An automotive grade nitrous oxide which is a cryogenic gas consisting of two nitrogen molecules bonded to one oxygen molecule is used in the P.O.P. Q45 NOS. This gas is sold and marketed under the brand name Nitrous Plus and is produced solely by Puritan Bennett. It differs from the medical grade nitrous oxide in that it includes trace amounts of sulfur dioxide (5 ppm) to prevent substance abuse.

Under ambient pressure and temperature conditions, nitrous oxide exists in a gaseous state. In automotive applications, nitrous oxide is stored as a liquid in a DOT approved pressure vessel. Bottle pressure is kept in the 800-1000 psi range. As nitrous oxide is removed from the bottle the remaining supply of nitrous oxide undergoes a phase change (liquid converted to gas) to restore equilibrium in the bottle.

V. DISCUSSION OF THE P.O.P. Q45 NOS

An engineering evaluation was conducted on the NOS kit to determine its impact on vehicle emissions and durability.

A. Emission Impact

The NOS kit injects liquid nitrous oxide into the engine's intake tract when two conditions are satisfied: the arming switch is "on" and throttle is at the WOT position. Injecting nitrous oxide into the inlet tract of an engine produces a decrease in the engine's inlet air temperature due to the latent heat of vaporization caused by the injection of nitrous oxide into the air inlet track. Additionally, nitrous oxide is a stronger oxidizer than ambient air (36 percent oxygen by weight as compared to 21 percent oxygen by weight for ambient air). The combination of nitrous oxide and fuel results in a mild increase in horsepower and torque when compared to the stock configuration.

Effective use of the NOS kit requires wide-open throttle operation. However, the Cold Start CVS-75 Federal Test Procedure (FTP), which is the official ARB test procedure for evaluating the emission impact of add-on or modified parts, does not take into account emissions during wide-open-throttle conditions. Testing the NOS kit using the CVS-75 FTP procedure will not show any effect on emissions because the kit will not be operational during the test cycle. The Air Resources Board is currently developing off-cycle testing to address the emission impact of devices such as the NOS kit which operate only when outside of the CVS-75 FTP drive cycle. Until off-cycle procedures are developed, the impact of the NOS kit on vehicle emissions can not be determined.

The staff looked into potential chemical reactions which could occur when liquid nitrous oxide is injected into the inlet mixture. The staff is not aware of any studies conducted to date which shows the actual chemical reaction occurring in the vehicle's engine when injected with nitrous oxide. Studies conducted on stationary sources such as the petrochemical industry (their processes have waste gases containing high levels of nitrous oxide), have shown that nitrous oxide decomposes at sufficiently high temperatures to either nitric oxide (NO) or Nitrogen (N_2) and Oxygen (O_2). In the presence of rich fuel, NO reacts with hydrocarbon fragments to form intermediate species X-N ($HCN + NH_3$). Depending on the temperature and air/fuel conditions, remaining fuel fragments may be oxidized fully into CO_2 and H_2O and the nitrogen species (NH_3 , HCN or NO) may be reduced to molecular nitrogen or oxidized to NOx. These chemical reactions are likely to occur in a vehicle injected with nitrous oxide. However, without the proper test procedures, relative amounts of NOx and HC can not be quantified. The manufacturer stated use of nitrous oxide is minimal because

of its high cost (\$2.50 per pound; a pound of nitrous oxide is approximately equivalent to 10 seconds of vehicle operation).

B. Durability

The staff also evaluated the NOS kit for its effect on the durability of the vehicle's emission control system, specifically the potential degradation of the oxygen sensor and the catalytic converter.

A literature search was conducted by Nitrous Oxide Systems, Inc. (NOS, Inc.), the hardware manufacturer of the Jim Wolf Racing P.O.P. Infiniti Q45 NOS, on all Society of Automotive Engineers (SAE) papers from 1965 to present regarding the performance of exhaust gas oxygen sensors. Based on the literature search, oxygen sensor failure could either be mechanical or chemical. Mechanical failure was attributed to external structural damage or internal separation of components caused by impact or excessive vibration. Chemical failure was attributed to poisoning due to presence of lead, phosphorus, zinc, calcium, or silica. Nytrous Plus (automotive grade nitrous oxide) contains no elements known to contribute any exhaust gas oxygen failure or performance degradation.

Degradation of the catalytic converter has been known to accelerate when exposed to sulfur. The sulfur content of current pump gasoline varies between 30 to 3000 ppm, whereas Nytrous Plus contains only 5 ppm. Therefore, based on comparative sulfur content, any degradation in the catalytic converter will be due to the sulfur content in the fuel. To demonstrate that the effect of sulfur from nitrous oxide injection is insignificant, NOS, Inc. conducted a mass flow analysis of fuel and nitrous oxide using a 1990 5.0L Mustangs and a 1991 5.0L Pontiac Firebird. Using typical customer usage rates (5 lbs/week), sulfur contributed by nitrous

oxide injection would be between 1 to 2 percent of the total sulfur consumed by the vehicle.

The use of nitrous oxide can result in an increase in exhaust gas temperature, a factor critical to life expectancy and degradation of the catalytic converter. Due to these concerns, Jim Wolf Racing volunteered to demonstrate that no substantial increase in exhaust temperature would be observed by conducting comparative exhaust temperature testing. Testing was conducted at the Los Angeles County Raceway in Palmdale, California with representatives from the ARB present to observe the tests. A 1992 Infiniti Q45 was used in the tests which consisted of four 0 to 80 miles per hour (MPH) stand still to WOT drag strip style runs, two tests to record baseline temperatures and two tests to measure the modified temperatures. The test vehicles were equipped with data loggers to record the catalyst inlet and bed temperatures. Since testing was conducted on a drag strip and not under controlled laboratory conditions, the staff anticipated low repeatability of data. Also, the data logger is manually engaged/disengaged which could attribute to some variability in test data. Therefore, a temperature increase of up to 10 percent over the baseline was considered to be insignificant. Furthermore, staff deems the 0 to 80 MPH acceleration test to be the worst case condition, which will rarely occur when the vehicle is under normal street driving.

Results of the 0 to 80 MPH runs on the 1992 Infiniti Q45 are shown in Appendix which demonstrates that no significant increase in catalyst inlet or exhaust temperatures were observed from the use of the P.O.P. NOS kit. All catalyst bed temperatures recorded were far below the 1700 degrees F upper limit recommended by catalyst manufacturers.

Jim Wolf Racing submitted all the required information and has met the requirements for an exemption.

APPENDIX

TABLE 1.

INFINITI Q45 80 MPH TEMPERATURE VALUES

<u>Test</u>	<u>Configuration</u>	<u>Inlet</u> (Degrees Fahrenheit)	<u>Outlet</u>	<u>Catalyst</u>
#1	Baseline	1410	1390	Driver Pre-Cat
#1	Baseline	1275	975	Driver Main Cat.
#1	Baseline	1475	1325	Passenger Pre-Cat.
#1	Baseline	1310	1025	Passenger Main Cat.
#2	Baseline	1410	1400	Driver Pre-Cat.
#2	Baseline	1275	950	Driver Main Cat.
#2	Baseline	1495	1325	Passenger Pre-Cat.
#2	Baseline	1325	1025	Passenger Main Cat.
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#3	Nitrous Oxide	1395	1375	Driver Pre-Cat
#3	Nitrous Oxide	1200	910	Driver Main Cat.
#3	Nitrous Oxide	1475	1250	Passenger Pre-Cat.
#3	Nitrous Oxide	1250	975	Passenger Main Cat.
#4	Nitrous Oxide	1425	1395	Driver Pre-Cat.
#4	Nitrous Oxide	1250	895	Driver Main Cat.
#4	Nitrous Oxide	1510	1310	Passenger Pre-Cat.
#4	Nitrous Oxide	1310	975	Passenger Main Cat.

Average Baseline	1410	1395	Driver
	1485	1325	Pre-Cat.
	1275	963	Passenger
	1318	1025	Pre-Cat.
Average Nitrous Oxide	1410	1385	Driver
	1493	1280	Pre-Cat.
	1225	903	Passenger
	1280	943	Pre-Cat.
Difference	+0 or 0%	-10 or 0.7%	Driver
	+8 or 0.5%	-45 or 3%	Pre-Cat.
	-50 or 4%	-60 or 6%	Passenger
	-100 or 8%	-82 or 8%	Pre-Cat.