State of California
AIR RESOURCES BOARD

EXECUTIVE ORDER D-76
Relating to Exemptions under Section 27156
of the Vehicle Code

NORDSKOG INDUSTRIES, INC.
"NORDSKOG INDUSTRIES DATSUN ENGINE CONVERSION KIT"

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 of the Health and Safety Code and Executive Order G-30A;

IT IS ORDERED AND RESOLVED: That the installation of the "Nordskog Industries Datsun Engine Conversion Kit" manufactured by Nordskog Industries, Inc., 16000 Strathern Street, Van Nuys, CA 91406, 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 the following applications:

(1) Engine conversions of 1970 through 1973 Datsun 240Z using the same or newer 1970 through 1974 Chevrolet 350 CID engine, with automatic transmission, and the required vehicle emission control system.

(2) Engine conversions of 1974 Datsun 260Z using 1974 Chevrolet 350 CID engine, with automatic transmission, and the required vehicle emission control system.

This Executive Order does not constitute any condonation or approval of the safety of such modified vehicles when operated on the highway.

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.

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 "NORDSKOG INDUSTRIES DATSUN ENGINE CONVERSION KIT".

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 Sacramento, California, this 20th day of October, 1977.

Thomas C. Austin
Deputy Executive Officer

State of California
AIR RESOURCES BOARD

September 10, 1977

Staff Report

Evaluation of Nordskog Industries, Inc. "Nordskog Industries Datsun Engine Conversion Kit" for Compliance with the Requirements of Section 27156 of the California Vehicle Code

I. Introduction

Nordskog Industries, Inc., 16000 Strathern Street, Van Nuys, California 91406, has applied for an exemption for its Datsun Engine Conversion Kit from the prohibitions of Section 27156 of the California Vehicle Code (Exhibit A). Section 27156 prohibits the advertisement, sale and installation of any device or mechanism which reduces the effectiveness of the required motor vehicle emission control system.

The kit is specifically designed for the engine conversion of Datsun 240Z and 260Z series vehicles from 1970 through 1974 model years. The Datsun engine is replaced with the same year or newer Chevrolet 350 CID engine with all required emission control equipment and the original Chevrolet automatic transmission. The replacement engine for California certified Datsun "Z" cars must be of California configuration.

II. System Description

The Nordskog Industries Datsun Engine Conversion Kit provides the components and instructions on how to replace the Datsun engine with the equivalent used Chevrolet 350 CID engine. It consists of 22 separate sub-kits and installation instructions (Exhibit B).

The sub-kits consist of a special low profile air cleaner, engine cooling system; header system, power train mounts, fuel system, electrical system and other accessories as itemized in Page 15 of the attached installation instructions. Additional parts have to be procured by the customer to complete the engine replacement. These include the applicable Chevrolet 350 CID engine along with the matching automatic transmission, water pump, starter, alternator, evaporative emission control system, drive shaft, and supplemental parts itemized in page 3-5 of the attached installation instructions. A tune-up label is also supplied with the kit to be affixed to the converted vehicle.

The installation instructions provides guidance on how to procure the replacement Chevrolet 350-CID engine and other supplemental parts needed, tools and equipment check list, pre-installation service procedures, power train removal and replacement, installations of the components supplied by the manufacturer, road test and diagnostic test procedures.

III. System Evaluation

The proposed engine conversion kit requires the removal of the engine and the emission control systems from a certified Datsun vehicle and replacement with an equivalent Chevrolet 350 CID engine with its indigenous emission control systems. The purpose of this evaluation is to determine if the engine conversion will result in an increase in emissions of the modified vehicle compared with the unmodified vehicle originally certified to meet emission standards for that model year.

A. Technical Background

The replacement Chevrolet 350 CID engine is designed and certified for vehicles with 4,500 to 5,500 lbs gross vehicle weight (GVW) rating. When the engine is installed on a Datsun "Z" car chassis, the GVW of the vehicles will not exceed 3500 lbs. Since the GVW of the converted vehicle is lighter the road load horsepower[1] requirement of the Chevrolet 350 CID engine will be less in a Datsun chassis than in a Chevrolet chassis.

The ARB conducted a test program to determine the emission effects[2] of varying the inertia weight and horsepower loading. Emission tests were conducted on a 1974 Chevrolet 350 CID vehicle using the CVS-72 test procedures. The study concluded that HC, CO and NOx emissions vary in the same direction as the change in chassis dynamometer inertia weight setting and horsepower loading of the vehicle.

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[1] Road Load Horsepower = $V\ (CrW+CaAV^2+0.01GW)/375$

Where Cr = Coefficient of rolling resistance.
Ca - Coefficient of air resistance
V = Vehicle speed, mph
A = Frontal area of the vehicle, ft^2
W = Gross vehicle weight, lbs
G = road grade, per cent

[2] Effects on Exhaust Emissions of Varying Horsepower Loading and Inertia Weight on a 1974 Chevrolet, 350-4V ARB Report R7702, September 1977.

Studies conducted by others[3] showed that at constant speed decreasing the horsepower output decreases NOx and CO emissions, whereas, the HC remains relatively constant. The decrease in NOx production can be attributed to a decrease in maximum cycle temperature as a result of reduction in engine load. The reduction of fuel consumption also reduces CO mass emissions. The influence of load on HC emissions is quite complex. A factor tending to decrease HC emission as load is decreased is increased residence time within the exhaust system; factors tending to increase HC emission include increased quench thickness and decreased exhaust temperature as load is decreased. Apparently the opposing factors on HC emission offset each other causing no change in HC emission as load is decreased at constant speed.

B. Test Evaluation

The above technical discussions indicate that the replacement by a larger displacement engine would not result in an increase of vehicle emissions. However, the proposed engine conversion kit requires the modifications of various other vehicle components such as exhaust, cooling, fuel system, etc. to allow for the exchange of engines. In addition, problems may be encountered in actual practice that may affect vehicle emissions which need to be investigated. Therefore a test program was conducted at the ARB Laboratory to evaluate the actual engine conversion utilizing the proposed kit.

[3]D. F. Hagen and G. W. Holiday, The Effect of Engine Operating and Design Variables on Exhaust Emission, SAE No. 486C, 1962

Edward F. Obert, Internal Combustion Engines and Air Pollution, Intext Educational Publishers, New York, 3rd Edition, 1973.

I. Test Program

The testing was conducted in cooperation with the applicant who supplied the two Datsun vehicles and performed the required conversion using the Nordskog conversion kit. The following were the test vehicles confirgurations:

a. 1973 Datsun 240Z with automatic transmission and modified with a 1973 Chevrolet 350-4V, A.T. (From a Caprice)

b. 1974 Datsun 260Z with manual transmission and modified with a 1974 Chevrolet 350-4V, A. T. (From a 1/2 ton truck)

The vehicles were given normal pre-conditioning and set to appropriate engine specifications. In addition, a compression check was made on each vehicle to determine the condition of the engines, and the calibration curve of the distributors were verified. The following emission tests were performed on the above vehicles (in the original configuration and the converted configuration):

a. Cold Start CVS-75

b. Two Hot Start CVS-72

c. CVS Loaded Mode Tests

d. CVS Steady State at 30, 40 50 mph with chassis dyno set at 3X road load horsepower

e. EPA Highway Cycle Test

f. Evaporative Emission (Shed) Test

2. Problem Areas

During the test evaluation several problems were identified and corrected when possible, as discussed below:

a. When the modified Datsun 240Z was delivered for testing, inspection of the vehicle indicated some installation deficiencies. The exhaust manifold flange was leaking, the steering bar was scrapping against the header pipe causing a steering problem, the transmission would not downshift in some instances, and bolts holding the driveshaft bracket were loose. These problems were later corrected. A leaking exhaust flange was detected on the converted Datsun 260Z which was also corrected prior to testing.

b. Initial emission tests on the modified Datsun 240Z showed about a tenfold increase in CO compared to the unmodified vehicle. A failure mode analysis traced the problem to a carburetor malfunction. In addition, the carburetor was found to be intended for a truck engine application only. The defective carburetor was replaced with a service carburetor specified for the 1973 Chevrolet 350 CID engine and the emission tests were repeated.

c. The Chevrolet engine with an automatic transmission installed in the Datsun 240Z was certified with a manual transmission. The illegal switch of transmissions was probably performed by the previous owners and would not typically represent the engine configurations available for replacement.

d. The Chevrolet 350 CID installed in the Datsun 260Z was completely rebuilt. This type of replacement configuration would be preferable but would not necessarily occur in practice.

e. Engine conversions increased the weight of the Datsun 260Z by about 200 lbs, and the 240Z by about 100 lbs. The weight increase was concentrated at the front end of the vehicles. This weight change distribution may put undue stress on the front suspension and unsafely affect vehicle operation and stability. In addition the brake system originally designed for the Datsun vehicles might not adequately handle the requirements of the more powerful and heavier converted vehicles. These concerns were not investigated in depth since they relate to safety and not emissions.

3. Test Results

Comparative emission data from the testing of the original and modified 1973 Datsun 240Z is summarized in Table I, and from the 1974 Datsun 260Z in Table II. Data from the initial testing of the modified Datsun 240Z was not included in Table I since the original carburetor was defective and had to be replaced. Hot start CVS-72 test procedures performed on a 1973 Chevrolet 350-4V simulating the Datsun "Z" car inertia weight and road load horsepower requirement from a previous study[4] was also included in Table I and II for comparison.

[4]Ibid 3

a. 1973 Datsun 240Z

The official CVS-75 and Hot Start CVS-72 data showed about a 40% reduction in HC and 35% in NOx emissions after the engine conversion. The Highway Cycle Test as well as steady state tests showed about the same magnitude of reductions. The change in CO emissions was not consistent, however. In most cases CO emissions increased with the engine conversion. The evaporative emission (SHED) test indicated no adverse effect on the evaporative system integrity due to the engine conversion. Fuel economy decreased by over 40%.

b. 1974 Datsun 260Z

The official CVS-75 test showed about a 30% decrease in HC and CO emissions and no significant change in NOx after the engine conversion. On the Hot Start CVS-72 HC decreased by 15% and CO by 29% with no change in NOx. Data from Highway Cycle and Steady State Tests generally showed substantial decrease of emissions. The evaporative emission test also showed significant reduction of HC mass emission. Fuel economy decreased by about 30%.

c. 1973 Chevrolet 350 CID Emission Simulation

The Hot Start CVS-72 test on a 1973 Chevrolet 350-4V vehicle simulating the Datsun "Z" car showed HC, CO, and NOx emissions lower than both the unmodified 240Z and 260Z cars.

As predicted, exhaust emissions generally decreased with the vehicle conversions using the larger size engine. The increase in CO on the modified Datsun 240Z, however, was an anomally. Comparison of the two modified Datsun vehicles emissions (both use Chevrolet 350 CID engines although of different model years) showed that the modified Datsun 240Z has significantly higher CO emission. The increase of CO emission on the modified Datsun 240Z may be attributed to different carburetor calibration since the service carburetor used was not the original equipment part.

Conclusion and Recommendation

The proposed Nordskog Industries, Datsun Engine Conversion Kit will allow the installation of a more powerful Chevrolet 350 CID engine on Datsun "Z" car chassis. If all the emission control components of the replacement engine are retained, theoretically the vehicle emissions should decrease or not change significantly after the conversion. Evaluation of two typical Datsun conversion confirmed the above prediction. The fuel economy, however, decreased significantly.

The applicant performed the actual engine conversions during the test evaluation yet various problems become apparent. Although most of these problems were corrected easily during the testing, the same problems may be encountered by the consumers intending to perform the engine conversions who are not adequately equipped to correct or detect the problems. To prevent increase of emissions due to carburetor or ignition malfunction (a frequent problem) appropriate diagnostic and service procedures are required in the installation instructions.

A major concern is the safety of the converted vehicle. Since the ARB has no authority to evaluate vehicle safety, it is recommended that a copy of this report be transmitted to the California Highway Patrol for appropriate action it deems necessary.

Since the use of the proposed engine conversion kit is not expected to result in an increase in exhaust emissions of the converted vehicles, it is recommended that Nordskog Industries, Inc. be granted an exemption from the prohibitions of Section 27156 of the Vehicle Code for its "Nordskog Industries Datsun Engine Conversion Kit".

Table I - Emission Test Data
of 1973 Datsun 240Z

CVS - 75

	Grams Per Mile			
	HC	CO	NOx	MPG
Baseline	3.0	17.7	2.3	19
Modified Datsun	1.7	20.5	1.5	11.3
% Change	-43	16	-35	-41

CVS - 72

Chevrolet (240Z Simulation)*	0.9	6.2	1.07	12
Baseline (2 Tests)	1.7	14.9	2.2	20.8
Modified Datsun (2 Tests)	1.1	10.5	1.5	11.8
% Change from Baseline	-35	-30	-32	-43

Highway Cycle

Baseline	1.2	8.4	2.6	25.3
Modified Datsun	0.6	10.9	1.9	14.8
% Change	-50	30	-27	-42

Loaded Mode

Idle	Mass Emissions Grams per Min.		
	HC	CO	NOx
Baseline	0.8	19.1	0.07
Modified Datsun	0.2	0.7	0.09
% Change	-75	-96	29

* 1973 Chevy 350-4V tested at Datsun 240Z inertia weight setting and road load horsepower.

Table I Continued

Low Cruise

	Grams Per Mile			
	HC	CO	NOx	MPG
Baseline	1.3	2.6	2.9	23.8
Modified Datsun	0.7	6.9	2.0	14.0
% Change	-46	131	-45	-41
High Cruise				
Baseline	1.4	5.1	3.3	19.1
Modified Datsun	0.6	9.3	4.2	11.9
% Change	-57	82	27	-38
Steady State (3 Times road load)				
30 MPH				
Baseline	1.4	2.6	3.0	27.1
Modified Datsun	0.5	7.0	1.0	15.8
% Change	-64	170	-67	-42
40 MPH				
Baseline	1.1	3.3	2.8	20.8
Modified Datsun	0.5	13.0	2.3	13.6
% Change	-55	294	-18	-35
50 MPH				
Baseline	1.5	22.5	5.6	16.5
Modified Datsun	0.7	12.0	5.4	11.7
% Change	-53	-44	-4	-26

Table I Continued

Evaporative Emission (SHED) Test

	HC, Grams		
	Diurnal	Hot	Total
Baseline	0.3	9.5	9.8
Modified Datsun	0.8	10.3	11.2
% Change			4

Table II - Emission Test Data
of 1974 Datsun 260Z

CVS - 75

	Grams Per Mile			
	HC	CO	NOx	MPG
Baseline	3.0	13.7	1.5	16.2
Modified Datsun	2.0	9.9	1.5	12.4
% Change	-33	-28	0	-23

CVS - 72

Chevrolet (240Z Simulation)*	0.9	6.2	1.07	12
Baseline (2 Tests)	2.0	11.8	1.4	16.7
Modified Datsun (2 Tests)	1.7	8.4	1.4	13.7
% Change from Baseline	-15	-29	0	-18

Highway Cycle

Baseline	1.0	3.6	1.2	22.2
Modified Datsun	0.7	5.0	2.3	15.6
% Change	-30	39	92	-30

Loaded Mode

	Mass Emissions Grams per Min		
	HC	CO	NOx
Baseline	0.2	7.1	0.02
Modified Datsun	2.1	0.6	0.04
% Change	950	-91	100

* 1973 Chevy 350-4V tested at Datsun 240Z inertia weight setting and road load horsepower.

Table II Continued

Low Cruise

	Grams Per Mile			
	HC	CO	NOx	MPG
Baseline	0.8	2.5	1.6	25.8
Modified Datsun	0.6	2.9	0.6	17.6
% Change	-25	16	-63	-32
High Cruise				
Baseline	1.1	4.2	3.2	17.9
Modified Datsun	0.6	2.4	1.4	17.0
% Change	-45	-43	-56	-5
Steady State (3 Times road load)				
30 MPH				
Baseline	0.8	2.5	1.5	27.6
Modified Datsun	0.5	2.2	0.5	18.4
% Change	38	12	-67	-33
40 MPH				
Baseline	0.8	3.5	1.7	20.5
Modified Datsun	0.4	2.2	0.9	18.8
% Change	-50	-59	-47	-8
50 MPH	0.8	5.0	5.4	16.6
Modified Datsun	0.4	2.2	1.7	17.5
% Change	-50	-56	-69	5

Table II Continued

Evaporative Emission (SHED Test

	HC, Grams		
	Diurnal	Hot Soak	Total Mass
Baseline	0.3	11.9	12.2
Modified Datsun	0.6	8.9	9.6
% Change			-21