

State of California
AIR RESOURCES BOARD

EXECUTIVE ORDER D-225-20
Relating to Exemptions Under Section 27156
of the Vehicle Code

CRANE CAMS, INC.
FORD INTERCEPTOR DOWNSTREAM ENGINE MANAGEMENT SYSTEM

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 Ford Interceptor Downstream Engine Management System (Interceptor) manufactured by Crane Cams, Inc. of 530 Fentress Blvd., Daytona Beach, FL 32114 has been found not to reduce the effectiveness of the applicable vehicle pollution control system and, therefore, is exempt from the prohibitions of Section 27156 of the Vehicle Code for 1990 to 1992 Ford Mustangs powered by a 302 CID (5.0L) V-8 gasoline engine.

This Executive Order is valid provided that the installation instructions for the Interceptor will not recommend tuning the vehicle to specifications different from those submitted by Crane Cams, Inc.

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

Marketing of the Interceptor using any identification other than that shown in this Executive Order or marketing of the Interceptor 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 Interceptor 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 that the use of the Interceptor 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 Interceptor may adversely affect 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 Interceptor 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 Interceptor will affect the durability of the emission control system, Crane Cams, Inc. 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.

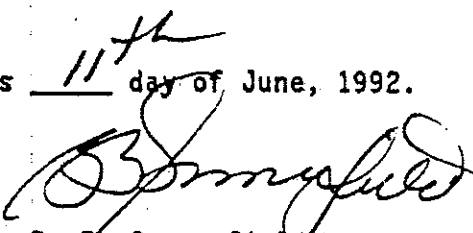
In addition to the foregoing, the ARB reserves the right in the future to review this Executive Order and the exemption provided herein to assure that the exempted add-on or modified part continues to meet the standards and procedures of Title 13, California Code of Regulations, Section 2222, et seq.

THIS EXECUTIVE ORDER DOES NOT CONSTITUTE A CERTIFICATION, ACCREDITATION, APPROVAL, OR ANY OTHER TYPE OF ENDORSEMENT BY THE AIR RESOURCES BOARD OF CLAIMS OF THE APPLICANT CONCERNING ANTI-POLLUTION BENEFITS OR ANY ALLEGED BENEFITS OF CRANE CAMS' INTERCEPTOR.

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 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 11th day of June, 1992.


R. B. Summerfield
Assistant Division Chief
Mobile Source Division

State of California
AIR RESOURCES BOARD

EVALUATION OF CRANE CAMS, INC.
FORD INTERCEPTOR DOWNSTREAM ENGINE MANAGEMENT SYSTEM FOR EXEMPTION FROM THE
PROHIBITIONS OF VEHICLE CODE SECTION 27156 IN ACCORDANCE WITH
SECTION 2222, TITLE 13, OF THE CALIFORNIA CODE OF REGULATIONS

June 1992

State of California
AIR RESOURCES BOARD

EVALUATION OF CRANE CAMS, INC.
FORD INTERCEPTOR DOWNSTREAM ENGINE MANAGEMENT SYSTEM FOR EXEMPTION FROM THE
PROHIBITIONS OF VEHICLE CODE SECTION 27156 IN ACCORDANCE WITH
SECTION 2222, TITLE 13, OF THE CALIFORNIA CODE OF REGULATIONS

by

Mobile Source Division
State of California
Air Resources Board
9528 Telstar Avenue
El Monte, CA 91731

(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

Crane Cams, Inc. has applied for an exemption from the prohibitions of the Vehicle Code Section 27156 for their Ford Interceptor Downstream Engine Management System (Interceptor) for installation on 1990-92 Ford Motor Company Mustangs, sold in California under AB965, equipped with a 302 HO (5.0L) V-8 gasoline engine. Crane Cams has submitted a completed application and all the required information, as well as exhaust emissions test data performed at Crane Emissions Laboratory and E.C.S. Laboratories, Inc.

Based on the submitted information and the results of the emissions tests performed at both laboratories, the staff concludes that the installation of Crane Cams' Interceptor will not adversely affect exhaust emissions on the specified vehicles when tested in accordance with the Cold Start CVS-75 Federal Test Procedures.

The staff recommends Crane Cams, Inc. be granted an exemption as requested and that Executive Order D-225-20 be issued.

TABLE OF CONTENTS

	Page Number
SUMMARY	i
CONTENTS	ii
I. INTRODUCTION	1
II. CONCLUSION	1
III. RECOMMENDATION	1
IV. DESCRIPTION OF THE FORD INTERCEPTOR	1
V. DISCUSSION OF THE FORD INTERCEPTOR	4
APPENDIX	6
Software configuration	
Installation instructions	

EVALUATION OF CRANE CAMS, INC. FORD INTERCEPTOR DOWNSTREAM ENGINE MANAGEMENT SYSTEM FOR EXEMPTION FROM THE PROHIBITIONS OF VEHICLE CODE SECTION 27156 IN ACCORDANCE WITH SECTION 2222, TITLE 13, OF THE CALIFORNIA CODE OF REGULATIONS

I. INTRODUCTION

Crane Cams, Inc. of 530 Fentress Blvd., Daytona Beach, Florida 32114, has applied for an exemption from the prohibitions of Vehicle Code Section 27156 for their Ford Interceptor Downstream Engine Management System (Interceptor) for installation on 1990-92 Ford Motor Company Mustangs, sold in California under AB 965, equipped with a 302 (5.0L) V-8 gasoline engine. Crane Cams has submitted a completed application and all the required information, as well as exhaust emissions test data performed at Crane Emissions Laboratory and E.C.S. Laboratories, Inc.

II. CONCLUSIONS

Based on the submitted information and the results of the emissions tests performed at both laboratories, the staff concludes that the installation of Crane Cams' Interceptor 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 Procedures.

III. RECOMMENDATION

The staff recommends that Crane Cams, Inc. be granted an exemption as requested and that Executive Order D-225-20 be issued.

IV. DESCRIPTION OF THE FORD INTERCEPTOR

The Interceptor is specifically designed for installation on 1990-92 Ford Motor Company Mustangs that are equipped with a 302 (5.0L) V-8 gasoline engine. The Interceptor is an electronic programmable controller, designed to enhance the vehicle performance without interfering with the emissions

related functions. Certain features of the Interceptor extend the capabilities of the stock control system in the areas of performance and security.

The Interceptor is comprised of three components: an engine controller, a hand-held data terminal, and a wire harness. The ancillary items include a cable to connect the hand-held terminal to the controller and an Owner/Operator Manual. The hand-held terminal has two windows, allowing access to a LCD display screen and a 20-key, membrane-type keypad for data entry and command selection. The hand-held terminal weighs 280 grams. The wiring harness consists of three connectors and bundles of individually insulated wires covered with a protective loom. Two of the connectors mimic those found in the stock ECU/Vehicle harness junction. The third connector plugs into the three components modular connector on the controller.

The Interceptor is installed between the stock ECU (Electronic Control Unit) and the vehicle harness. Of the 44 signal lines present between the vehicle harness and the stock ECU, 20 lines are passed through, 15 lines are monitored, and 9 lines are intercepted. "Passed through" means that a given signal line is connected directly from the vehicle harness to the stock ECU without interruption or contact with any other circuit. "Monitored" means that a given signal is unaffected. "Intercepted" means a given signal could be modified.

The Interceptor can modify two basic signals: fuel injector pulses and spark out. The fuel injection pulses are modified in three ways. During operation below the factory rpm limit, injector pulse widths may be modified to provide more or less fuel. The second mode of fuel signal modification takes place during what will be termed "extended rpm operation" beyond the

stock fuel cutoff speed. The third way of modifying fuel pulse signals is shutting off the fuel pulses when a user chosen engine speed is reached. Adjustment limits for fuel can be set at a maximum of ± 24 percent from base setting. The spark out signal is the command sent to the Ford ignition module which then produces a spark. Adjustment limits for timing can be set at a maximum of ± 20 degrees from base setting. Variable driving conditions will not allow the use of a fixed minimum and maximum value for fuel injector pulses and spark out. This is why the Interceptor uses a progressive or regressive implementation table which allows the vehicle to operate without experiencing driveability problems. This implementation table will only allow the vehicle to see specified values which the manufacturer has determined will not affect vehicle driveability even if the minimum and maximum values are preprogrammed. See Appendix A for implementation values.

The Interceptor also provides the user information about the operation of the engine and the operation of the Interceptor itself. These functions display data on the LCD screen when the Interceptor is in the "monitor mode." The engine information functions display the current values of engine speed (in rpm), throttle opening (in %), oxygen sensor state (R or L), fuel pulse duty cycle (in %), and total spark advance (in degrees). These data items are updated with a frequency of about 10 Hz (10 times a second), and thus reflects essentially "real-time" values.

The Interceptor provides user interface through the LCD display and keyboard of the hand-held terminal, and software which directs the user's inputs and reports the status of the Interceptor. There are three modes of operation: system setup, monitor, and data set editing. Setup requires initial inputs of engine cylinders, type of air flow measurement (Mass

Air/Speed Density), and injector scheme (bank/simultaneous/sequential). The monitor allows the user to view real-time values of important engine control signals. Once the Interceptor is programmed with the necessary system setup data, the monitor mode becomes the default screen during normal vehicle operation. Data set editing allows the user to make adjustments to any of the three available data sets without destroying previously saved data.

V. DISCUSSION OF THE FORD INTERCEPTOR

A 1991 Ford Mustang (AB 965) powered by a 302 CID engine was used for the evaluation of the Interceptor. Emission tests conducted by Crane Emissions Laboratory consisted of four cold-start CVS-75 emission tests with the Interceptor installed on the test vehicle. The four cold-starts were used by Crane and ARB to determine worst case emission parameters of the Interceptor. The results were evaluated against the emission standards as demonstrated in Table 1.

Table 1

CVS-75 TEST RESULTS

(Crane Emissions Laboratory)

	<u>HC</u>	<u>CO</u>	<u>NOx</u>
Emission standards	0.41	3.4	1.0
#1 +24% fuel -20 degrees spark	0.18	2.00	0.47
#2 -24% fuel +20 degrees spark	0.15	0.29	0.78
#3 +24% fuel +20 degrees spark	0.20	2.35	0.57
#4 -24% fuel -20 degrees spark	0.13	0.39	0.61

The ARB also required Crane to conduct two additional CVS-75 emissions tests, test #2 & #3 as described in Table 1, at an ARB recognized independent laboratory. Vehicle exhaust emissions in the two modified configurations were compared with the applicable emission standards. These results are shown in Table 2.

Table 2
CVS-75 TEST RESULTS
ECS Laboratories, Inc.

	<u>HC</u>	<u>CO</u>	<u>NOx</u>
Emission standards	0.41	3.4	1.0
#1 -24% fuel +20 degrees spark	0.21	0.33	0.86
#2 +24% fuel +20 degrees spark	0.22	1.26	0.77
Difference #1	-0.20	-3.07	-0.14
Difference #2	-0.19	-2.14	-0.23

Both CVS-75 emissions test results at Crane Emissions Laboratory and ECS Laboratories, Inc. indicate that HC, CO and NOx emissions of the vehicle with the Interceptor installed are below the emission standards. This demonstrates that the installation of the Interceptor for 1990 to 1992 Ford Mustangs equipped with a 302 CID (5.0L) V-8 gasoline engine will not adversely affect exhaust emissions when tested in accordance with the Cold Start CVS-75 Federal Test Procedures.

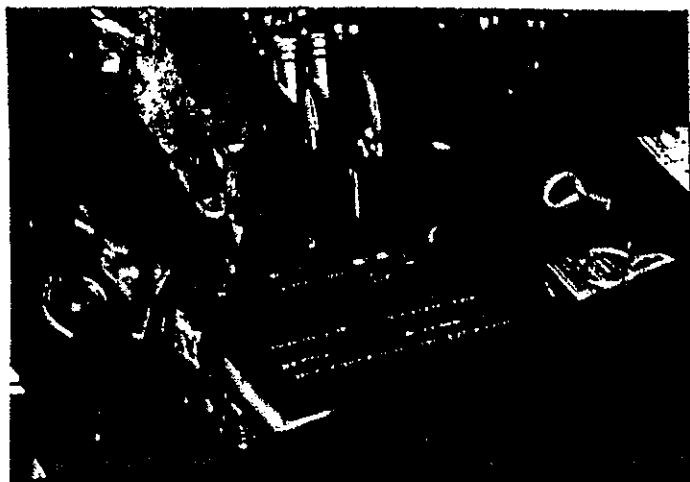
Crane Cams has submitted all the required information and fulfilled the requirements for an exemption. The test results confirmed that Crane Cams' Interceptor meets the requirements for the exemption.

APPENDIX

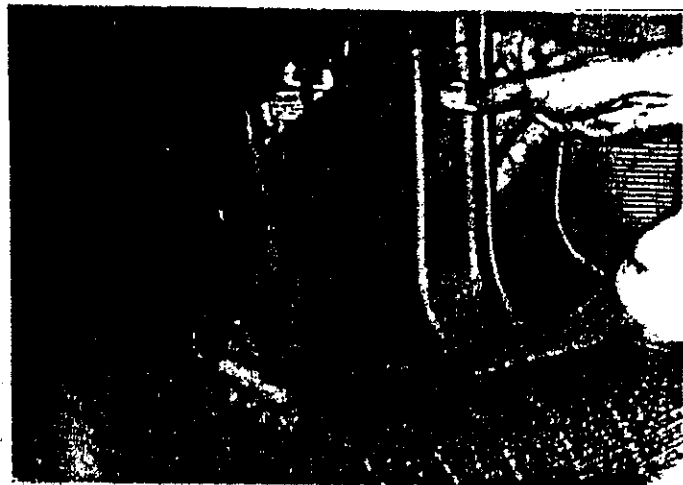
Mode:	Load	RPM	Adjustment Limits			
			Fuel		Spark	
			Min	Max	Min	Max
Idle	N/A	N/A	-20%	+10%	-4°	+4°
Part Throttle	Low	<2200	-16%	+10%	-4°	+4°
	Mid	<2200	-16%	+10%	-4°	+4°
	High	<2200	-16%	+10%	-4°	+4°
	Low	2200-4000	-24%	+24%	-20°	+20°
	Mid	2200-4000	-24%	+24%	-20°	+20°
	High	2200-4000	-24%	+24%	-20°	+20°
	Low	4000-5800	-24%	+24%	-20°	+20°
	Mid	4000-5800	-24%	+24%	-20°	+20°
	High	4000-5800	-24%	+24%	-20°	+20°
WOT	N/A	<2200	-24%	+24%	-20°	+20°
	N/A	2200-4000	-24%	+24%	-20°	+20°
	N/A	4000-5800	-24%	+24%	-20°	+20°

Installing the Interceptor

Unpack the Interceptor, noting the four components: the controller (metal box), the Hand-Held Terminal (plastic box), the harness (black), and the data cable (gray or beige). You will need the following hand tools to install your Interceptor: wrenches of 7/16", 10mm and 7mm sizes, a medium-size Phillips screwdriver, a small flat screwdriver, and a razor blade or knife. Proceed with the installation in the steps shown below.



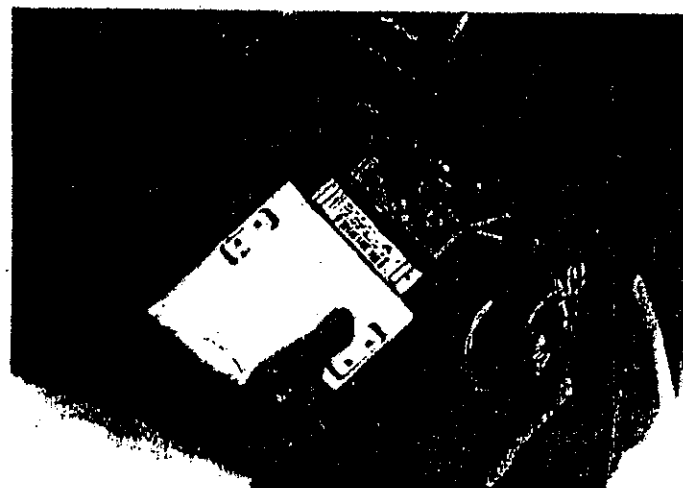
Step 1: Disconnect the negative battery terminal using the 7/16" wrench. Set the cable end aside, clear of the battery post.



Step 2: Remove the passenger-side kick panel. It is held in place by one Phillips-head screw on the door jamb and a plastic drive pin (shown).



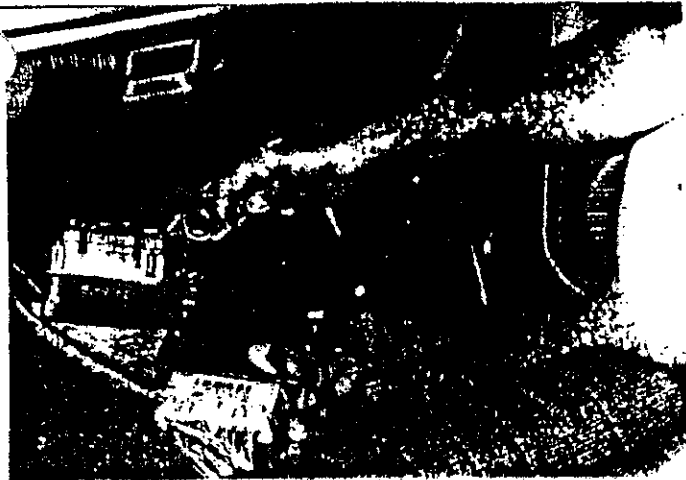
Step 3: Locate the stock computer and the plastic "cage" which holds it in place. Remove the anchor screw for this cage (either Phillips-head or 7mm) and hold the cage clear as you slide the stock computer out. On some vehicles, a grounding wire must be removed first.



Step 4: Once the stock computer has been freed from the kick panel, use the 10mm wrench to loosen the retaining screw in the center of the harness connector. Backing it out separates the connector from the computer. Continue until the computer is free from the harness.



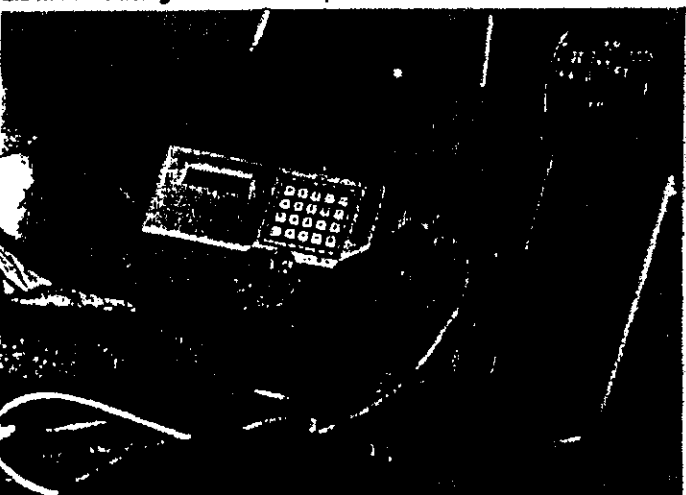
Installing the Interceptor



Step 7: Place the vehicle harness/Interceptor harness pair under the carpeting in the passenger footwell. Reinstall the stock computer in its original location, locating it with the plastic cage. Replace the cage anchor screw.



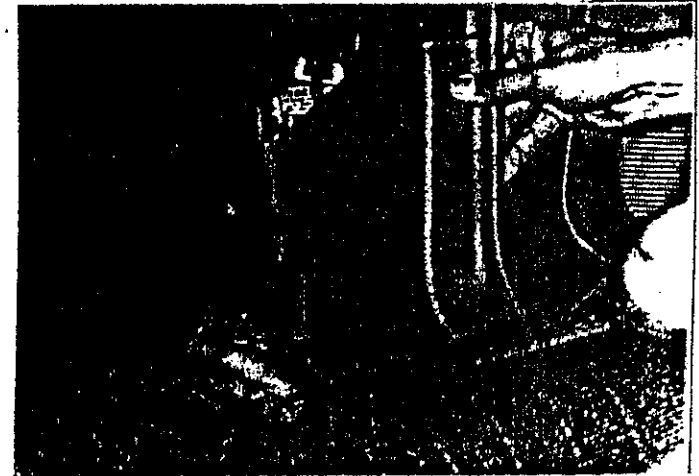
Step 9: Lead the end of the harness under the seat and out between the front two seat posts. Connect the data cable to the Interceptor controller and tighten the two anchor screws. Connect the controller to the harness using the three black push-lock connectors.



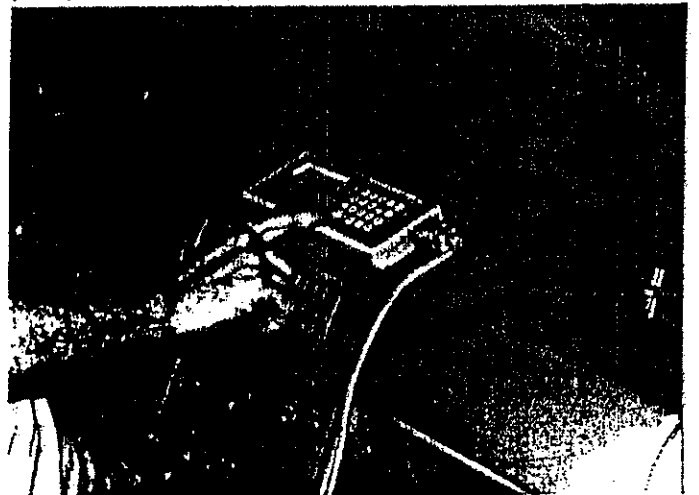
Step 11: Lead the data cable from under the seat and connect the free end to the Hand-Held Terminal. Tighten the retaining screws snug. Make sure the data cable is routed so as not to get caught in the door.



Step 8: Route the remaining leg of the Interceptor harness under the carpeting along the door sill. Make a 2-3 inch slit in the carpet as shown and lead the harness through the slit and under the seat. Leave the edge of the carpet along the sill exposed until Step #10.



Step 10: Push the controller under the seat, rotating it so the Data Cable points toward the driver. It fits snugly in the depression under the seat. Replace the kick-panel cover and replace the screws and push-pin. Push the exposed carpet edge back and tighten the screws.



Step 12: Find a convenient spot for the Hand-Held Terminal. Reconnect the negative battery terminal. You are now ready to proceed to the final system check.

DO NOT ATTEMPT TO START YOUR VEHICLE!
Proceed to the next page to learn more about the Interceptor.