

DEPARTMENT OF TRANSPORTATION  
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

UNITED STATES GOVERNMENT

## memorandum

Subject: Engineering Analysis (EA9-049) - Radio  
Frequency Interference to Automotive  
Electronics - Cadillac Seville Fuel  
Injection Systems and Ford Ignition Systems

Date: APR 04 1980

From: Safety Defects Engineer  
EAD

Reply to  
Attn. of: NEF-13sr

To: Acting Chief *WHR*  
EAD

BASIS

In 1977 and 1978, NHTSA, Research and Development, with cooperation of the National Bureau of Standards (NBS), conducted a variety of electromagnetic interference (EMI) tests, also known as radio-frequency interference (RFI) tests, with respect to the different FMVSS No. 121 anti-lock systems used on heavy duty trucks. During one of these tests in which ODI participated in November 1978, we observed a potential EMI susceptibility problem to the electronic ignition system of a 1979 Mercury Zephyr. The Zephyr, equipped with an on-board 100 watt mobile transmitter, experienced stalling whenever the transmitter microphone was keyed "on" and left "on." We were later informed by the NBS that Ford performed a similar test on another 1979 Zephyr in an attempt to duplicate our observation.

In February 1979, we received a consumer complaint from Mr. Ralph Liuzzi stating that he had installed a mobile transmitter in his customer's Cadillac Seville and that every time he attempted to transmit with the engine running, the engine would stall. In view of these complaints and the lack of documentation on the effects of EMI on automobile electronic engine control systems, an engineering analysis was opened on February 15, 1979, to study possible safety implications of this phenomenon.

INPUTS

On March 13, 1979, we wrote to Ford inquiring about their experience with EMI relative to their electronic ignition system. On March 20, 1979, a letter was sent to GM requesting information relating to EMI in their vehicles equipped with electronic fuel injection (EFI) and/or High Energy Ignition (HEI) systems.



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## 1. General Motors Corporation

GM's May 11, 1979, response to our inquiry indicates that the EMI problem is limited to a few instances where an owner attempted to operate an on-board mobile transmitter in a Cadillac equipped with electronic fuel injection. There were 13 of these reports. GM had not received any reports of EMI relative to vehicles equipped with the High Energy Ignition (HEI) system alone. In general, GM believes a properly installed mobile transmitter will not interfere with the Cadillac's EFI system. However, to take care of any exceptions, the owner's manual for the 1979 Seville advises the owner to contact the Cadillac Customer Services Department for assistance if he is considering installing a radio transmitter other than a mobile telephone (installed by local telephone company), a citizens band radio, or an electronic garage door opener. Mr. Morrison of GM indicated to this ODI representative by phone conversation on May 25, 1979, that all of the reports were limited to on-board mobile transmitter interference. Mr. Morrison also stated that GM has informed the two-way radio manufacturers of the potential for EMI and instructed them to refer all consumer ~~complaints relating to EMI to GM.~~ With regard to Mr. Liuzzi's complaint, Cadillac has contacted the owner to resolve the problem with the cooperation of Motorola, the radio manufacturer.

GM has requested that Attachment "D" of their May 11, 1979, response be treated as confidential, since it contains engineering test data relative to product development concerning the EMI problem. The Office of Chief Counsel granted confidentiality of this material by memo dated September 24, 1979, to ODI.

## 2. Ford Motor Company

Ford's May 11, 1979, response to our inquiry contained 64 reports of EMI relative to Ford vehicles equipped with electronic ignition systems. These reports mention engine stumble, hesitation, and stalling, occurring as a result of on-board mobile transmitter activation.

Seventy-five percent of the vehicles mentioned in the reports were 1978-1979 Ford built police package type vehicles equipped with the Dual Mode (DM) electronic ignition module. Police package vehicles such as these are normally sold to State Police departments and County Sheriffs' offices. A majority of the reports concerned police vehicles since the users of these vehicles are more likely to install a high power (40 to 100 watt) mobile transmitter in the vehicle than the average consumer. Eleven percent of the vehicles in the reports were commercial, privately owned, and U.S. Government owned Ford built vehicles having DM ignition modules and on-board transmitter installations. The remainder of the vehicles included Fords equipped with ignition systems other than the DM.

A review of the reports furnished by Ford, revealed an alleged accident due to on-board transmitter EMI. This was reported to Ford by the Pennsylvania State Police, Harrisburg, Pennsylvania. The report stated that the vehicle, a 1978 LTD II police package, was involved in a high speed chase. The driver reportedly keyed the transmitter microphone "on" and the motor cut out. When the driver released the microphone key, the motor started up again, at which time the vehicle hit an icy spot. The vehicle then reportedly went out of control and into the median strip.

Laboratory and field testing by Ford appears to indicate that the DM module is more susceptible to on-board transmitter interference than the other Ford ignition modules. The observed failure mode is as follows: with the transmitter activated (microphone switch to "on" position) the electromagnetic radiation is conducted into the DM module by way of the vacuum switch and its leads. This results in severely impaired spark timing and dwell, and eventually leads to engine stumble, hesitation, or stalling. Ford's investigations into the reports reveal the following as possible causes for on-board transmitter EMI: (1) improper installation of the transmitter or its associated wiring, (2) excessive antenna/transmitter impedance mismatch, or (3) improper antenna location.

Many of the EMI complaints have been resolved by merely correcting the transmitter equipment installation and in some cases by moving the ignition module. When this does not correct the problem, substitute DM ignition modules are installed. The "substitute" modules are of the same design as the DM module with the exception that it has 3 ferrite beads on the leads to the vacuum switch which act as low pass filters. While it is true that the modified DM module is a field fix for police radio EMI, the actual corrective action necessary to eliminate the interference may vary from vehicle to vehicle depending on transmitter frequency, transmitter type, antenna location as well as other factors. In some cases, the modified DM module fix only corrected the problem when the ignition module was mounted in a certain location. Ford has been handling this problem on a complaint basis. A Ford memorandum of August 24, 1978, states that in the event of transmitter related ignition complaints, the district representative will provide the dealer with a kit containing a test module and instruction sheet. Ford has been in further contact with customers such as the police fleets who have experienced the EMI problem, to follow-up the corrective actions and discover any new problems. The Ford "Problem Report" of July 25, 1978, states that Customer Service has reported all problem vehicles, the first occurring in February 1978. This tends to indicate that the appropriate Ford Engineering personnel are actively aware of all of the EMI complaints.

One of the 64 reports stated that a Ford police car with a transmitter could interfere with the ignition of a similar vehicle (equipped with the DM ignition) if the vehicle was in close proximity to the transmitter in the adjacent lane. In a test performed by Ford, vehicle to vehicle interference could only be caused when the transmitting vehicle's antenna was within 6 inches of the other vehicle. The vehicle body provides a substantial amount of shielding to the ignition system so that the probability of lane to lane interference is fairly low.

As of May 1, 1979, Ford stated that no design changes were made to the ignition modules for reducing EMI. However, Ford did state that the modified dual mode ignition module (the current field fix) "is planned for use in future production of police vehicles employing such modules". Mr. Ted Richardson of Ford indicated to this ODI representative by phone conversations on March 25 and 26, 1980, that Ford has elected not to install the modified DM module on new police packages, since it will not cure the EMI problem in all cases. In the cases where it does not, a "taylor made" fix depending on the vehicle is required. It should be noted that the on-board transmitter EMI problem will not occur in all cases.

Mr. Richardson also stated that a newsletter has been sent to Ford service personnel advising them to contact Ford Motor Company in Dearborn when they learn of police radio EMI reports from dealers.

#### ANALYSIS

Both Ford and GM invested considerable resources to develop automotive electronic engine control systems that are immune to EMI. The problem of EMI is a relatively new one in automotive technology, since electronics have only recently been introduced into usage in automobiles. The research and development into EMI effects and their elimination is still in the state of the art stage.

The on-board transmitter EMI problem in GM Cadillacs equipped with electronic fuel injection is more limited than in the case of the Fords, since Cadillacs are generally not used in police fleets or as emergency vehicles.

The major two-way radio manufacturers have been informed by GM of the potential for EMI to Cadillacs.

Mr. Richardson of Ford Motor Company has informed this ODI representative by phone conversation on March 26, 1980, that Ford does not install the two-way radios in the police package vehicles. This is done by the police fleets themselves.

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Although several of the reports Ford received indicated that the vehicles had accumulated some mileage before they experienced the EMI, the nature of the problem is such that it should generally show up the first time the driver attempts to operate a transmitter with the engine running. In actuality there is no one single fix for the problem, as it will differ slightly from vehicle to vehicle.

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*Stuart D. Rednor*

Stuart D. Rednor