FINAL REPORT

A STUDY OF COMPONENTS
INFLUENCING THE DETERIORATION OF
VEHICLE EMISSION CONTROL SYSTEMS

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ABSTRACT

A fleet of eighteen 1979 to 1981 model year vehicles completed an emission component calibration inspection and test program. The vehicles were selected from those failing one or more emissions standards after completion of a California Air Resources Board (ARB) in-use vehicle surveillance program. The work was performed at the Automotive Research Center of Olson Engineering Inc. (OEI) in Huntington Beach, California.

A baseline CVS-75 emissions test was performed on each vehicle after an initial inspection and repair or adjustment of basic parameters, vacuum hose routing and visible emission component malfunctions. After the baseline test, inspection of all testable emission components was completed using new vehicle certification calibration information. Those components not within calibration were replaced. A catalytic converter efficiency test was performed on most catalysts. Additional CVS-75 emissions tests were performed to determine the effectiveness of the repairs.

Of the eighteen vehicles that completed the program, twenty-nine occurrences of emission levels above standard existed. Upon completion, fourteen occurrences of emission levels above standard existed and two of those were ten percent or less above standard. Six vehicles passed all three standards after repairs. Five vehicles were still failing one or more standards after all testable components and parameters were found to be within manufacturer specification. The remaining seven vehicles had various identifiable or suspected problems that could not be repaired or confirmed due to expense, unavailable parts or unavailable special test equipment. The fleet reductions in emission levels were 27%, 45% and 16% for HC, CO and NOx respectively. Fuel economy was unchanged.

It was concluded that bringing all verifiable emission components within certification specifications does not ensure that the in-use vehicle will be brought into compliance with emission standards. It was further concluded that the methods and procedures available to a well equipped emissions laboratory facility (and presumably to persons evaluating certification applications) are not sufficient to verify that the broad range of emissions related components are within calibration.

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DISCLAIMER

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SECTION 1

SUMMARY AND CONCLUSIONS

SUMMARY

A program was performed to investigate causes for high in-use vehicle emissions in order to identify possible improvements to the new vehicle certification process, emission component durability and future surveillance programs. Detailed emission control component calibration inspections and exhaust emission tests were performed utilizing a fleet of twenty-four 1979 to 1981 model year vehicles that were still failing by 15 percent or more after completion of an ARB in-use vehicle surveillance program. The study was performed by the Automotive Research Center of Olson Engineering Inc. in Huntington Beach, California. The inspection and testing phase of the study took place between August 1981 and July 1982.

Twenty-four vehicles were procured over that period of time. Fifteen were purely domestic, three were captive imports and six were imports. The vehicles were subjected to an inspection and test protocol that included:

- An initial inspection and correction of basic tuneup parameters, vacuum hose routing, and emission component installation.
- A baseline CVS-75 emissions test.
- A complete inspection of the functional operation and calibration of emission control component parts.
- Replacement of out-of-specification components.
- A catalytic converter efficiency test.
- An additional CVS-75 emissions test to determine effectiveness of the repairs.
- Additional diagnosis and testing (as approved by the ARB project engineer) if the vehicle was still failing.

Six vehicles were found to be not eligible to complete the entire protocol. Of the eighteen vehicles completing the entire

protocol, six passed their respective emission standards after repair. Of the twelve vehicles still failing one or more standards, five were within manufacturer specifications.

Eighty-seven items were initially found to be out of adjustment, not within calibration limits or were broken upon removal.

The major functional categories of deteriorated components and adjustments and the number of occurrences are:

- o Tuneup Parameters (24)
- o Vacuum Management (21)
- o Temperature Management (13)
- o Electronic Control (11)
- o Air/Fuel Control (10)
- o Catalytic Converter (3)
- o EGR (3)
- o Ignition (2)

The items with the highest occurrence rates are:

- o Timing Maladjustment (8 vehicles)
- o Spark Plug Maladjustment, Heat Range or Fouling (8 vehicles)
- o Thermostat Stuck or Out of Calibration (8 vehicles)
- o Distributor Thermal Vacuum Switch Bad (6 vehicles)

The effect of individual adjustments and component replacement cannot be specifically determined. The first two items were generally corrected before the baseline emissions test was performed. All components and adjustments found to be out of calibration were generally corrected before the next emissions test was performed.

While the magnitude of the improvement for each component change or adjustment cannot be determined, the vehicles demonstrating the greatest reduction in emission levels from their baseline failing levels were those that received an OEM replacement carburetor (2), catalyst (2) or electronic control unit (3). The vehicles that had the high occurrence components replaced (without replacement of any of the three components just listed) demonstrated relatively modest improvements.

Every attempt was made to perform all calibration tests prescribed, but the complexity of some components and subsystems required special test equipment or procedures not available to a well equipped emissions laboratory (or to the ARB). Even manufacturer service manuals are not complete in their procedures related to calibration inspections, relying instead on functional tests and part substitution as the primary methods of diagnosis.

When diagnostic information can be provided by the on-board microcomputer (ECU), it must be extracted using a special tester or through what proved to be an unreliable method using a built-in diagnostic indicator system. Of the seven vehicles equipped with this built-in diagnostic feature, six showed either proper operation (code "12") or the code that was flashed was incorrect. The "CHECK ENGINE" light came on during engine operation for only one vehicle, but the trouble code flashed was for components that were already verified as good. The ECU was replaced in this instance. This on-board diagnostic feature is excellent in concept but appears to be limited in its ability to identify a wide range of specific faults.

The emission test results showed significant improvements in all three pollutants, without any change in fuel economy. The fleet emission levels in grams per mile and fuel economy in miles per gallon for baseline and final tests are:

	HC	CO	NOx	MPG
Baseline	0.564	9.307	1.101	19.177
Final	0.413	5.085	0.928	19.176
% Change	-26.77	-45.36	-15.71	-0.01

A more complete discussion of emission test results for the fleet, by model year and by manufacturer is given in Section 6.

FINDINGS AND CONCLUSIONS

The small size of the sample investigated and the variation in type of control system and in manufacturer render the development of conclusions somewhat difficult. Given this caveat, the following findings and conclusions are presented.

1. Most of the vehicles failing the standards were failing due to out-of-specification components.

2. The replacement of out-of-specification components brought many of the vehicles back within their prospective standards.

3. When all components are brought within manufacturer's specifications, a significant decrease in fleet emissions can be obtained.

4. Bringing all verifiable emission components within certification calibration does not ensure that the in-use vehicle will be brought into compliance with emission standards. This conclusion is supported by a recently reported agreement between General Motors and the EPA.*

5. The methods and procedures available to a well equipped emissions laboratory are not sufficient to verify that the broad range of emissions related components are within calibration. This observed limitation presumably would also apply to EPA and ARB personnel and facilities when evaluating certification applications.

6. Functional tests are not sufficient to show that individual components are within calibration since many of the failed components were still functioning, but at the wrong operating condition, or were providing erroneous "proper operation" indications in the case of several of the diagnostic ECUs.

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* "GM Prevents a Recall Via New, Clean Cars", **Automotive News**, August 9, 1982.

7. Replacement parts are not always locally available and, more significantly, when available are not always within calibration specifications. Several of the parts could only be located at the manufacturer's home warehouse. Sophisticated computer inventory searches were even used in attempts to locate parts.

8. The reasons for failure of nearly all of the components in this study cannot be specified as to whether they were due to deterioration, to in-service misuse or misadjustment or to bad components originally installed at the time of manufacture.

9. Some parts are not designed for removal, calibration verification and reinstallation. The thermal vacuum switch and coolant temperature sensor are prime examples. The plastic parts used and soft metal wrench flats make destruction upon removal very likely.

SECTION 2

RECOMMENDATIONS

The findings and conclusions indicate a need for better specification and control of the various emission control components. Some of the following recommendations address this problem specifically and some address it on a secondary level. The recommended approach is to provide as much meaningful information as possible from the emission data and durability data vehicles included in the certification process.

CALIBRATION VERIFICATION PROCEDURES

It is recommended that calibration verification procedures, using generally available laboratory equipment and personnel, be included in the certification application process. By performing suitable component durability testing and verifying minimum deterioration, in-use performance can be improved.

COMPUTER VERIFICATION OF CALIBRATION VALUES

The sophistication of modern automotive electronics is such that analog values (emission component calibrations) can be sampled periodically and be identified as out-of-specification. It is recommended that automatic compensation and/or visual displays indicating a failure be provided to ensure that emission component specifications are maintained for the useful life of the vehicle.

EMISSION COMPONENT SELECTION

Emission critical components are presently subjected to test procedures and criteria according to 40 CFR 85.2122. Appendix VIII to 40 CFR Part 85 outlines vehicle and engine parameters and specifications that are to be reported as part of the certification process. The selection of components and adjustments within the reported tolerances are assumed to be such that favorable emission levels will be obtained throughout the certification emissions test process.

It is recommended that the calibration values of components and adjustments be selected such that these components and adjustments are biased toward increased emission levels (e.g. the worst case 75th percentile of the reported calibration tolerances).

REPORTING OF SPECIFIC CALIBRATION DATA

The specific calibration data for adjustments and individual components used in emission data and durability data vehicles are only reported at the beginning of the mileage accumulation process. Good engineering practice suggests that these data are also collected by the vehicle manufacturer at the end of the mileage accumulation process in order to assess the durability of these parts. This information can provide a valuable input to the establishment of expected stock levels for replacement parts.

It is therefore recommended that the actual measured values of these component calibrations and adjustments at both zero miles and at the completion of mileage accumulation and testing be required data and be submitted to the certifying agency as part of the certification process.

The result is likely to be the accumulation of valuable information in the establishment of a library of emission sensitive components. The ability to assign meaningful deterioration factors to individual components (or classes of components) would result and could potentially reduce the requirements of the certification process.

The identification of emission sensitive components with high rates of deterioration could allow emphasis on the calibration testing of these components and ensure an adequate supply of replacement parts, leading to more cost-effective maintenance of in-use vehicles. A complimentary effect of the implementation of this recommendation would be more durable parts due to the requirement for non-destructive removal of the parts from durability data vehicles at 50,000 miles for calibration testing.

SERVICE REPLACEMENTS

Replacement parts are subject to variations in performance due to manufacturing tolerances in man and machine operations. With all of the manufacturers stressing quality in their products, the tight control of these variations for emissions critical components would seem to be in line with manufacturer goals.

It is therefore recommended that a statistical sampling of emission control components be selected on a regular basis and be subjected to the same calibration test procedures used to determine calibration values of components reported on for emission and durability data vehicles. A report of this information (perhaps quarterly) would be submitted to the appropriate certifying agency.

A trial quality assessment program for emission components currently in the parts network is discussed below.

CURRENT REPAIR PART AVAILABILITY AND CALIBRATION

It was found that several parts were unavailable at the dealer level and that those available could be out of calibration tolerance. It is recommended that a statistical sampling of testable emission system components be identified from among the major U. S. and foreign automobile manufacturers for a few major engine families. Attempts should be made to obtain these parts from various dealers and aftermarket suppliers in metropolitan areas throughout California. The delays in delivery or unavailability of the parts would be noted. Upon receipt, the calibration of each component would be determined and verified against manufacturer tolerance. Good components could be returned to the manufacturer for credit, with perhaps a restocking charge. Bad components could be installed in test vehicles to determine the effect that the failed replacement part would have had.

VALIDATION OF EMISSIONS EFFECTS OF FAILED COMPONENTS

It is recommended that some of the failed emission components that were found during this present study be individually installed (or adjusted) to determine the effect of each failure on emissions. Since several of the vehicles had suspect but untestable calibrations, these vehicles would not be used. Approximately eight vehicles would be needed for this validation. The same vehicles used in the current study could be solicited to provide for the same effects of manufacturing tolerance accumulation. If not available, similar vehicles would be procured. The results would be used to identify individual components that do or do not have a significant individual or combination effect on emission levels.

SECTION 3

SCOPE AND PURPOSE

BACKGROUND

A representative sample of in-use light duty vehicles is continually being studied by the California Air Resources Board (ARB) as part of their program to monitor emission control systems. These studies have shown that the majority of in-use vehicles do not retain acceptable emission levels. Factors affecting this deterioration include lack of maintenance, maladjustment and disablement of emission control systems. Minor corrective adjustments and repairs will usually bring the emission levels of the majority of these vehicles to within their originally certified standards. However, some vehicles continue to demonstrate unacceptable emission levels after normal tuneup adjustments and repairs.

Data regarding emission levels, emission component specifications and engine specifications relative to emission levels are all submitted to the ARB for evaluation as part of the new vehicle certification process. The specifications include tolerances intended to reflect production variation and deterioration effects over the first 50,000 miles of the vehicle's life.

Analysis and approval of pre-production data prior to certification is apparently not sufficient to ensure that a representative sample of in-use vehicles can be made to pass all three exhaust emissions standards when the components and parameters are within manufacturer specifications.

In order to determine why some in-use vehicles exhibit emissions levels higher than experienced in new vehicle certification, the ARB issued a request for proposals in November 1980. Olson Engineering Inc. (OEI), as the successful proposer, was awarded a contract in July 1981 to study the components influencing the deterioration of emission control systems. The first vehicle in the project was received in August 1981.

OBJECTIVE

The purpose of this study was to identify the critical emission control parameters and functional components that detrimentally influence in-use vehicle emissions, and to measure the deterioration of these parameters and components relative to the specifications under which they were originally certified. The conclusions drawn from this study are to be used in formulating recommended changes to the current vehicle certification requirements, improving the durability of emission components and parameters for future vehicles and enhancing the focus of future in-use vehicle surveillance programs.

SCOPE

This study was originally limited to twenty vehicles that were previously tested in ARB in-use vehicle surveillance programs. The eligible vehicles were ones that were still failing one or more emissions standards after receiving manufacturer recommended maintenance. Six vehicles were subsequently deleted from the project (aborted) for various reasons described elsewhere. In order to stay within the budgetary constraints of the contract, the sample size of completed vehicles was reduced to eighteen.

These vehicles were inspected and tested using equipment normally available in a well-equipped emissions test laboratory. Documentation used in performing the inspections included certification calibration data supplied by the ARB, manufacturer service manuals (when available) and widely used general purpose emission control system manuals (Mitchell Manuals).

Baseline and repair verification emission levels were determined utilizing OEI's EPA qualified emissions test laboratory, using Federal Test Procedures.

TECHNICAL APPROACH

Each vehicle was subjected to a series of calibration tests, functional inspections, repairs and emissions tests intended to identify the components and parameters that were not within manufacturer specification. Repairs and adjustments were made to bring these components and parameters into specification. Cold start CVS-75 (also called CVS-II) emissions tests were performed to determine whether appropriate emissions standards were being met.

The protocol that was followed for each vehicle was essentially the same. Candidate vehicles were identified by the ARB. A subcontractor to OEI then transported the vehicle to OEI if it was currently in the ARB surveillance program, or attempted to obtain the vehicle if it had already been returned to its owner. Upon arrival at OEI, each vehicle was tested for residual lead in the fuel tank. Three vehicles were aborted due to higher than normal residual lead content. An examination of tuneup parameters was made along with an ignition system check using a computerized ignition analyzer.

The vacuum hose routing and the installation of emission components were verified. Any discrepancies that were found were corrected.

A baseline CVS-II test was then performed to identify the emission levels that were in excess of standard. These data were then provided to the ARB project engineer for his correlation with the ARB test results. The test results were also used as diagnostic information in support of the next step in the inspection process.

The emission control configuration and certification specifications for components and adjustment parameters were obtained from the ARB. This information was supplemented by factory shop manuals (when available) and by emission control service and repair manuals from Mitchell Manuals, Inc. Inspection procedures used were those given in the documentation just listed in the order of precedence as listed. When procedures were not identified or special equipment was required that was beyond the scope of this project, good engineering judgement was used to develop a calibration test procedure. If this proved infeasible, only a functional test was performed.

The operation of the catalytic converter was confirmed by a converter efficiency test. This test required installation of taps in the exhaust system ahead of the catalyst and behind the catalyst. The rear tap allowed for more efficient exhaust sample switching than taking the after-catalyst sample from the tail pipe. Efficiency was determined by calculating the percentage change of HC, CO and NOx emission levels before the catalyst to emission levels after the catalyst.

After the repairs and adjustments were made, an additional CVS-II test was performed to determine if each failing emission level had been reduced to a level better than standard. If the vehicle was still failing, the operations performed were reviewed for areas where additional inspections or analyses could be performed. The ARB project engineer was then consulted as to whether to continue or to return the vehicle to its owner.

The information gained from the inspection and testing performed by OEI is supplemented by a search of the literature available through the ARB, the Environmental Protection Agency, the Society of Automotive Engineers, the National Technical Information Service and the Library of Congress. Available reports pertinent to emission control component calibration inspection and deterioration for 1975 and later model years were reviewed first by title, then by abstract and finally by report content. Initially, only 1977 and later model years were considered, but so few reports were available that reports on all catalyst equipped vehicles were ultimately included.

LIMITATIONS

Limitations to component calibration inspection were primarily associated with the lack of equipment and procedures. Sophisticated and expensive equipment is available at the manufacturing level to test the various emission control components. Even then, this is most likely accomplished only on a representative sample basis. Procedures for calibration testing of these components are likewise only available at the manufacturing level. Most manufacturer service manuals provide only a functional test procedure or a part substitution approach. Some provide procedures utilizing expensive, specialized test equipment not generally available to a non-manufacturer emissions test laboratory.

SECTION 4

VEHICLE EVALUATION

INTRODUCTION

This section provides a narrative report of the results obtained and observations made during the conduct of the emission component calibration inspection and test protocol completed by OEI. Summary tables provide pertinent data within this section. A complete description of all vehicles procured for this project is included in Appendix A. Detailed explanations of problems found with each vehicle are lifted from each monthly status report, updated as necessary, and included herein as Appendix B. Data related to the emission component calibration inspections are listed in Appendix C. Computer printouts detailing CVS emissions test results are included in Appendix D. Converter efficiency test results are given in Appendix E.

VEHICLE PROCUREMENT

The vehicles used in this project were selected from vehicles previously tested by the ARB in their surveillance test programs. The procurement effort was subcontracted to Environmental Resource Management (e-r-m), the current contractor to the ARB for procurement of surveillance test vehicles.

Candidate vehicles were identified by the ARB project engineer from among those still failing after completion of the ARB surveillance test protocol. OEI then directed e-r-m to procure the vehicle(s). In some cases, the vehicle was already at the ARB El Monte laboratory so it was only necessary to negotiate a time extension with the vehicle owner and move the vehicle to OEI. In other cases, the vehicle had already been returned to its owner so it was necessary to resolicit its use. It was not always possible for e-r-m to obtain the vehicle desired. The random nature of failures of interest to the ARB and vehicle owner willingness to participate provided several perturbations in the test and inspection scheduling process.

Upon completion of the OEI project protocol, the information was reviewed, the ARB project engineer was notified when the vehicle was still failing one or more standards and then e-r-m was notified to pick up the vehicle and return it to its owner.

A description of each of the twenty-four vehicles that were initially procured for this project is given in Table 1.

INITIAL INSPECTION

Upon receipt, each vehicle was given a visual inspection to identify any damage, to check the integrity of the exhaust system, to check for any tampering of the fuel tank inlet restrictor and to measure the amount of residual lead in the fuel tank. Since even rare use of leaded gasoline can reduce the efficiency of the catalyst, it was desired that this use be identified as one of the first steps in the inspection process. The upper limit of lead allowed in "unleaded" gasoline is 0.05 grams of lead per gallon (gpg). In actual practice, unleaded gasoline generally contains from 0.01 to 0.03 gpg. Vehicles with lead levels greater than 0.04 gpg were considered suspect and the ARB project engineer was contacted regarding a decision to keep or abort these vehicles.

All lead tests were performed with the Science Essentials Company (Beckman Instruments) colorimeter test kit, using Mobil Method 1125-74. Fresh chemical reagents, test tubes and sample vials were procured at the start of the project. Calibration standards were also procured and used periodically to verify the proper operation of the instrument.

Three vehicles (8, 9, 10) were aborted from the project because their residual fuel tank lead levels were 0.04 or greater. Two other vehicles (13, 21) indicated high lead levels (0.088 and 0.048 respectively) but were retained in the project. Both tanks were drained, filled with unleaded gasoline and driven to flush the fuel system before the baseline CVS test was performed. More than 80 miles were accumulated on vehicle 21 in an attempt to ensure that the catalyst was rejuvenated as much as reasonably possible. Only a few miles were accumulated on vehicle 13 since the ARB loaded mode test had indicated that the catalyst was good and the vehicle had been driven from the ARB laboratory directly to OEI. The vehicle was fueled at a commercial gasoline station enroute and it was suspected that some tainted gasoline was obtained at that time. As it turned out, the ultimate replacement of the catalyst material brought the vehicle into compliance with all three emissions standards. The lead test results are listed in Table 1. The first four test results were not recorded due to an inadequate definition of data to be recorded. The values observed were all less than 0.03 gpg.

Once accepted into the program, each vehicle was checked to

TABLE 1

VEHICLE DESCRIPTIONS AND LEAD TEST RESULTS

VEH.	YEAR	MAKE	MODEL	LICENSE NO.	ODOM.	VIN NUMBER	LEAD CONTENT
1	1980	Chevrolet	Malibu	1ANR741	10,721	1W19AAR432293	Not Recorded
2*	1980	Audi	4000	701ZFE	41,349	81A0036045	Not Recorded
3*	1981	Dodge	Aries	1BPH080	23,663	112152	Not Recorded
4	1981	Dodge	Aries	1BTN432	17,025	145205	Not Recorded
5	1979	Ford	Wagon	324WZN	27,693	F9J76H124278F	0.017
6	1980	Buick	Skylark	DJM FIC	22,104	4C375AW287214	0.039
7	1980	Mazda	GLC	309ZYX	31,703	FA4US-640670	0.015
8*	1981	Plymouth	Champ	1CAG314	12,858	JP3BE3422BU500969	0.046
9*	1981	Plymouth	Sapporo	1BIM279	18,617	JP3BD4370BY800475	0.040
10*	1980	Plymouth	Champ	HEWITT1	18,615	1M24JA5903512	0.050
11	1981	Ford	Granada	1BPR101	9,731	1FABP27AXBG1211097	0.009
12	1980	VW	Jetta	595ZUS	28,283	16A0395752	0.021
13**	1980	Chevrolet	Caprice	1BVY838	10,496	1N47HAC128271	0.088
14	1980	Ford	Mustang	1ASL253	26,136	FOR02A157498F	0.021
15	1981	Datsun	310GX	1BJC925	18,636	JN1PN0656BM018283	0.016
16	1980	Mercury	Cougar	368YHC	26,212	F0H93F610303F	0.030 Avg.
17	1980	Oldsmobile	Cutlass	1ADK246	16,985	3R69AAM536472	0.025
18*	1981	Datsun	Pickup	1X44096	6,622	001398	0.033
19	1980	Oldsmobile	Delta 88	957YNU	22,951	3Y69RAY102918	0.036
20	1980	Chevrolet	Citation	180ZYB	28,084	1H115A6255357	0.017
21**	1980	Oldsmobile	Omega	885YZU	30,915	3B695AW198518	0.048
22	1979	BMW	528I	192ZBQ	43,144	WBA39910005333391	0.012
23	1980	Ford	Thunderbird	734ZOK	25,428	F0G87F103240F	0.011
24	1979	Cadillac	Seville	654XJL	31,751	6S69B99489602	0.013

*Aborted
**High Lead - Tank and fuel lines flushed with unleaded gasoline.

ensure that the tuneup parameters were set at the specifications listed on the vehicle emission control information sticker in the engine compartment. The vacuum hose routing was also verified using the underhood vacuum diagram. A visual inspection of required emission control hardware was made to ensure that it was installed and connected. Any discrepancies were repaired at this time.

The proper operation of the ignition system was verified using a SUN Model 2001 computerized ignition analyzer. A power balance test was also performed and when a problem with one or more cylinders was noted, a compression test was performed. Two vehicles (2 and 3) were aborted due to low compression. Repair of internal engine problems was outside the scope of this project.

For vehicles with the capability of computer memory storage of diagnostic trouble codes, the long term memory function was connected at this time. The trouble codes are lost from short term memory when the ignition key is turned off. For the models tested, the long term memory connection causes some battery drain so it was only connected until any information stored there had been extracted. It was connected during diagnostic inspection and prior to any emissions tests.

LABORATORY FACILITIES AND PROCEDURES

The laboratory equipment, environment and key personnel are recognized by the Environmental Protection Agency as qualified to perform the 1975 FTP and other emissions tests. Periodic audits are performed by the EPA to ensure continued qualifications. Calibration checks are performed at least as often as required by the Code of Federal Regulations.

The components of the OEI emissions tests facility used for this project consisted of two complete dynamometer, CVS and analytical bench systems and a contiguous cold soak area. A separate undiluted exhaust analysis bench was used to perform converter efficiency tests. Each component of each system meets or exceeds the requirements of 40 CFR Part 86. Other components not utilized in this project include a diesel test system, an evaporative emissions test unit (SHED), two engine dynamometers and a heavy-duty diesel exhaust analysis bench.

An adjacent building houses a 5000 square foot shop area where the parameters and calibration inspections took place. The shop is equipped with a SUN Model 2001 computerized ignition analyzer, a qualified HC/CO garage exhaust analyzer, a SUN distributor machine, a Bosch fuel injector tester and a large assortment of hand and power tools.

The test data quality assurance function is performed at OEI by a section completely separate from the testing function. Any test not performed in accordance with the Code of Federal Regulations (except for deviations allowed by contract) was rejected. Rejected tests were reviewed where necessary with the ARB project engineer. A few were accepted as-is where their results were used primarily for diagnostic purposes. Two tests previously accepted were rejected during the quality assurance review for the final report.

BASELINE EMISSIONS TESTING

Each vehicle was tested using the procedure generally described as the 1975 Federal Test Procedure, except that no evaporative emissions were measured (SHED test), a diurnal heat build was not performed and tank fuel was used. This test is also known as a CVS-II or CVS-75. The vehicles were preconditioned before each CVS-II test and then placed in a cold soak area (68^{o} to 86^{o}F with no restart) for a period of from 12 to 24 hours.

The baseline emission levels are included later in this section (Table 2) along with a listing of all CVS tests performed.

At some point after completion of the baseline test, the ARB project engineer was provided with the weighted test result numbers for comparison with results obtained during their surveillance testing of the same vehicle. Depending on actions performed between the ARB test and the OEI baseline test, the vehicle was found to be failing the same standard(s) and the magnitudes of the emissions levels observed were remarkably close. No ARB emission numbers were provided to OEI in advance of baseline testing.

One vehicle (18) received a timing adjustment as part of its initial inspection at OEI and subsequently passed all three emissions standards on its baseline test. The NOx level was a marginal pass. The vehicle was aborted from the program at this point.

CALIBRATION AND DIAGNOSTIC INSPECTIONS

The data used for calibration specifications was the information provided to the ARB as part of the manufacturer's application for certification. As each vehicle was procured, the ARB would compile and provide to OEI data sheets that it considered pertinent to the calibration inspection. While these data provided the specification values, they did not provide testing procedures. Procedures were developed using factory service manuals, supplemental service manuals (primarily Mitchell Manuals) and engineering judgement. Some of the later vehicles were the beneficiaries of procedures developed over several of the early vehicles. Where an actual calibration could not be performed, at least a functional test was performed.

It was not possible to perform all calibration inspections on all vehicles. Some procedures required specialized test equipment such as an electronic fuel injection tester or electronic control unit tester, or special laboratory equipment such as a flow bench for testing carburetors and some emission components. These pieces of equipment were not provided as part of this contract nor are they part of the equipment normally available at OEI. The equipment available to this contract (other than for CVS testing) is similar to that found in a well equipped independent service facility. OEI was able to borrow an EEC tester from a Ford dealer to accomplish the inspection for vehicle 5.

The calibration inspections that were performed and the results of these inspections are listed in detail for each vehicle in Appendix C. A narrative description of the exceptional, specific problem areas found for each vehicle is included in Appendix B. The method of presentation and data collection of calibration information was an evolutionary process, so some of the early vehicles lack completeness of detail that is provided for the later vehicles. Calibrations were checked (subject to the limits previously described) based on the data provided from the ARB. The calibrations were verified but not always documented as to actual value found. An example is the distributor advance curves. These were always verified as being within calibration but were not always plotted for the early vehicles.

The baseline emissions test was utilized as diagnostic information to assist the OEI project engineer in evaluating the results of the calibration inspection. For example, if it was not possible to test a particular component and that component had no effect on the failing pollutant, no further action was taken. However, if the component might have a deterimental effect on the failing pollutant, the ARB project engineer was contacted to determine if the ARB knew of or could find a calibration test procedure for the component. This effort was successful in a few cases.

ADDITIONAL EMISSIONS TESTING

The primary type of emissions test performed in addition to the baseline test was another CVS-II test following repair. For the early vehicles, especially vehicles 5, 6 and 7, the CVS-II test was used as a diagnostic tool to confirm or reject the effectiveness of parts suspected as being bad and replaced. This rather costly approach was based on the premise that the vehicle should be diagnosed and repaired until it passed all three emissions standards. This premise was modified to a point of view that all components and parameters should be verified as being within calibration specification, repairing any discrepancies found and then performing a final CVS-II test to determine a new level of exhaust emissions.

In a few cases, additional confirmatory tests were performed following consultation with the ARB project engineer. For vehicle 13, a hot start transient phase (Hot 505) of the CVS-II test was performed to confirm that a catalyst replacement was effective. For vehicle 14, it was decided to accumulate some mileage (230 miles) to "clean out" the engine after an ECU replacement. The emission levels of HC and especially CO worsened as a result of a NOx related repair on vehicle 20. This led to additional diagnosis and an eventual carburetor adjustment, followed by a final CVS-II test. The calibration inspection of vehicle 22 revealed only one suspect component (a temperature vacuum switch) and it was marginal. It was not replaced, but a very lean air/fuel ratio condition was corrected. The CVS-II test results indicated that perhaps the marginal TVS should have been replaced. This was accomplished, to the ultimate detriment of all three pollutants.

Catalytic converter efficiency tests were performed on 14 of the 18 vehicles completing the test and inspection protocol. This test was performed after a review of the baseline emissions test data and the calibration inspection data. Of the two vehicles for which the catalyst was replaced, one vehicle (7) had low converter efficiency results. The other vehicle (13) did not demonstrate low efficiency either during the OEI test or by the loaded mode test performed by the CARB. Upon the replacement of the catalyst, the emission levels were brought well within standard for all three pollutants.

EMISSIONS DATA SUMMARY

The computer printouts of the CVS tests and the results of the converter efficiency tests are given in Appendixes D and E respectively. A summary tabulation of the CVS tests that were performed is given in Table 2. The details of the cryptic REMARKS column can be found in Appendix B.

TABLE 2

LISTING OF CVS TESTS PERFORMED

Veh.	Test	Date	HC	CO	NOx	CO_2	MPG	REMARKS
1	CVS-II	8/13/81	0.601	6.247	0.957	482.158	17.962	Baseline
	CVS-II	8/22/81	1.009	8.380	0.800	470.547	18.219	Post Calibration
	CVS-II	8/25/81	0.367	3.390	0.772	494.967	17.691	ECU Replaced
	Standard		0.41	9.0	1.0			
2	None							Aborted - Low Compression
3	CVS-II	9/22/81	0.771	5.381	0.720	389.308	22.166	Aborted - Low Compression
4	CVS-II	9/25/81	0.583	8.147	0.687	412.301	20.778	Baseline
	CVS-II	10/02/81	0.277	3.115	0.640	405.808	21.562	Carb Replaced
	Standard		0.41	7.0	0.7			
5	CVS-II	10/01/81	0.868	5.212	3.644	696.591	12.538	Baseline
	CVS-II	10/05/81	0.735	4.492	3.092	671.442	13.030	EGR Pos Sensro Replaced
	CVS-II	10/12/81	0.878	5.359	2.438	634.245	13.744	ECU Replaced
	CVS-II	10/17/81	0.681	4.250	2.357	602.734	14.505	ECU Calibrator Replaced
	CVS-II	10/19/81	0.741	4.568	1.988	611.066	14.294	Several Items Replaced
	CVS-II	10/20/81	0.840	5.770	2.464	677.114	12.878	Eng Coolant Sw Replaced
	CVS-II	10/21/81	0.692	4.056	1.859	564.943	15.468	O_2 Sensor, Carb Reset
	CVS-II	10/22/81	0.612	3.764	1.527	520.949	16.776	Thermostat Replaced
	Data Invalidated Due to Suspected Exhaust Collection Leak							
	Standard		0.41	9.0	1.5			
6	CVS-II	10/13/81	0.228	4.191	1.281	374.622	23.227	Baseline
	CVS-II	10/17/81	0.234	3.983	1.300	389.318	22.384	ECU Replaced
	CVS-II	10/20/81	0.245	4.036	1.301	406.330	21.456	O_2 Sensor Replaced
	CVS-II	10/22/81	0.194	3.354	1.031	281.465	30.872	Carb Adjusted
	Data Invalidated Due to Suspected Exhaust Collection Leak							
	Standard		0.41	9.0	1.0			

TABLE 2

LISTING OF CVS TESTS PERFORMED (Continued)

Veh.	Test	Date	HC	CO	NOx	CO_2	MPG	REMARKS
7	CVS-II	10/26/81	1.102	16.232	0.776	279.532	28.752	Baseline
	CVS-II	11/03/81	1.268	14.428	0.665	261.022	30.833	Plug Change
	CVS-II	11/06/81	1.136	13.227	0.743	281.282	29.022	Carb Change
	CVS-I	11/09/81	0.069	0.563	0.283	329.313	26.848	Cat Replaced
	Hot Start test for repair confirmation.							
	CVS-II	11/10/81	0.137	1.483	0.853	308.465	28.504	Final
	Standard		0.41	9.0	1.0			
8	CVS-II	11/12/81	1.096	14.163	0.762	268.882	30.111	Aborted - High Lead
9	None							Aborted - High Lead
10	None							Aborted - High Lead
11	CVS-II	12/23/81	0.246	1.995	0.969	481.182	18.287	Baseline
	CVS-II	12/30/81	0.223	1.549	0.922	475.265	18.543	Thermostat Replaced
	Standard		0.41	7.0	0.7			
12	CVS-II	12/24/81	0.177	2.892	1.256	355.074	24.630	Baseline
	CVS-II	12/31/81	0.202	2.709	1.131	358.292	24.426	CO Adjusted
	Standard		0.41	9.0	1.0			
13	CVS-II	1/18/82	0.629	12.584	1.220	610.633	14.027	Baseline
	Hot 505	2/01/82	0.010	0.502	0.321	450.201	19.669	Cat Replaced
	CVS-II	2/02/82	0.297	4.284	0.337	592.258	14.787	Final
	Standard		0.41	9.0	1.0			
14	CVS-II	3/15/82	1.075	28.618	0.291	506.999	15.973	Baseline
	CVS-II	3/19/82	0.643	6.176	0.712	460.091	18.801	ECU Replaced
	CVS-II	3/26/82	0.470	5.036	0.659	447.935	19.397	After 230 miles
	Standard		0.41	9.0	1.0			
15	CVS-II	4/07/81	0.227	2.290	0.941	290.794	30.064	Baseline
	CVS-II	4/20/82	0.224	2.397	0.747	313.304	27.916	TVS, Vac Switch
	Standard		0.41	7.0	0.7			

TABLE 2

LISTING OF CVS TESTS PERFORMED (Continued)

Veh.	Test	Date	HC	CO	NOx	CO_2	MPG	REMARKS
16	CVS-II	4/12/82	0.614	3.038	1.254	522.383	16.766	Baseline
	CVS-II	4/16/82	0.526	3.299	1.324	540.957	16.194	Vac Reg Switch Replaced
	Standard		0.41	9.0	1.0			
17	CVS-II	4/16/82	0.265	5.438	1.278	480.966	18.091	Baseline
	CVS-II	4/23/82	0.345	5.786	1.097	476.875	18.214	Thermostat, TVS, Cool Sens
	Standard		0.41	9.0	1.0			
18	CVS-II	4/16/82	0.295	3.700	0.710	458.084	19.084	Aborted - Passed Baseline
	Standard		0.41	7.0	0.7			
19	CVS-II	4/28/82	0.756	8.169	0.990	555.365	15.547	Baseline
	CVS-II	5/03/82	0.526	8.353	0.862	566.187	15.269	Thermostat, TVS
	Standard		0.41	9.0	1.0			
20	CVS-II	5/14/82	0.267	6.791	1.299	398.817	21.619	Baseline
	CVS-II	5/20/82	0.328	10.860	1.061	379.727	22.299	Thermostat, Vac Hose
	CVS-II	6/04/82	0.616	6.702	0.718	439.906	19.609	Carb Adjusted
	Long crank plus 3 stalls on cold start							
	Standard		0.41	9.0	1.0			
21	CVS-II	5/19/82	0.553	17.723	0.944	397.072	20.791	Baseline
	CVS-II	5/24/82	0.366	9.474	1.039	416.771	20.496	TVS, Vac Hose
	Standard		0.41	9.0	1.0			
22	CVS-II	5/21/81	0.504	5.070	2.034	524.898	16.598	Baseline
	CVS-II	5/27/82	0.502	3.382	1.688	522.118	16.769	CO Adjusted
	CVS-II	6/04/82	0.587	4.874	2.163	536.406	16.249	TVS
	Standard		0.41	9.0	1.5			
23	CVS-II	6/11/82	0.679	5.747	0.670	593.686	14.666	Baseline
	CVS-II	6/22/82	0.615	4.395	0.611	572.781	15.252	Dist Maint, CWM
	Standard		0.41	9.0	1.0			
24	CVS-II	6/29/82	0.780	17.930	2.050	691.268	12.288	Baseline
	CVS-II	7/08/82	0.887	14.520	0.969	672.171	12.713	Thermostat, EGR, TVS,
	Standard		0.41	9.0	1.5			Coolant Sensor

SECTION 5

LITERATURE SEARCH

INTRODUCTION

A literature search was undertaken in order to supplement the information obtained from the inspection and test protocol followed in this project. The sources of information surveyed were:

- National Technical Information Service
  U. S. Department of Commerce
- Customer Service Section
  Catalog and Technical Publications
  Library of Congress
- SAE Publications Division
  Society of Automotive Engineers, Inc.
- Air Pollution Technical Information Center
  Environmental Protection Agency
- Vehicle Emissions Control Division Library
  California Air Resources Board
- Technical Library Services Division
  California State University Long Beach

A bibliography of the publications identified is given in Appendix F.

The intent of the literature search was to gather information regarding the types and effects of emission component deterioration on 1977 and later model year vehicles. The number of reports covering these model years was found to be severely limited so model years of 1975 and 1976 were also included. A similar emissions control strategy (the use of the catalytic converter) has been used since the 1975 model year.

SEARCH METHODOLOGY

A key word search was first undertaken in the broad categories of exhaust emissions, automobile emissions control, restorative maintenance, inspection and maintenance, emission component defects and deterioration and other related key words. The titles located were then examined for relevance to this project. Those with potential were further examined by a review of abstracts where available. Where the actual report was available, it was skimmed for content. Those with distinct potential were acquired from various sources. Not all publications of interest were available for final review.

The most fruitful source of index information was found to be the technical reference section in the library at California State University at Long Beach. EPA Publications Bibliography indexes for the years 1977 through 1981 provided 32 publications of promise. The index of California State Publications for 1977 through 1981 and the Extramural Research Report of July 1981 were reviewed with no success for the model years desired. Assistance was then provided by the personnel at the El Monte laboratory in the form of ARB surveillance reports and access to the ARB library.

RESULTS OF THE SEARCH

Of the fifty-one reports and papers with potential that are listed in the bibliography in Appendix F, twenty were able to be acquired and reviewed. The publications are referred to by the number given in the appendix.

The depth of information available is primarily superficial. Terminology varies somewhat so it is not possible to identify all of the components and parameters that are listed in the Analysis Section (Table 8) but those that are identifiable are listed in Table 3.

References in the table are listed generally in an order that reflects newer model year vehicles as the number increases. An exception is reference 47, which only included 1975 and 1976 model years. The percentages shown are generally as a percent of the total fleet.

Idle speed (curb and high) and basic timing adjustments continue to be parameters that are very commonly maladjusted. The sealing of idle mixture screws has significantly reduced the incidence of maladjusted idle CO.

Air/fuel control and EGR also continue to be common items of malperformance. A large incidence of EGR tampering occurred during the 1975 to 1977 model years, but tampering appears to be practiced less frequently in the more recent model years.

TABLE 3

LITERATURE SEARCH PROBLEM SUMMARY
PERCENTAGE OF REPORTED OCCURRENCES BY CATEGORY

CATEGORY	This Study	SOURCE* 15	16	17	18	19	47
Tuneup Parameters							
Curb Idle	11%	53%	45%	20%	16%	21%	
High Idle	17						
Basic Timing	44	70	35	17	12	11	29%
Spark Plugs	44	71					
Idle CO	17	74	55	29	14	23	
Temperature Management							
Thermostat	44						
Coolant Sensor	19						
Air Sensor	6						
Cold Weather Modulator	20						
Vacuum Management							
Hose/Routing	17	62					
Vacuum Leak	6						
Distributor TVS	33						
EGR/EFE TVS	25						
Purge TVS	11						
Vac Regulator Valve	20						
Vac Switching Valve	75						
Vac Delay Valve	6						
Exhaust Gas Recirculation			21	11		13	17
EGR Valve	13	100			4		
Position Sensor	100						
Ignition			26	10		11	
Advance	6						
Wires	6						
Electronic Control							
ECU	25						
O_2 Sensor	19						
Enrichment Solenoid	57						
Air/Fuel Control			19	10		17	55
Fuel Injection	100						
Carburetor	33						
Choke	7						
Air Filter	6	80					
Catalytic Converter							
Catalyst	17						

*Source number is bibliography reference number.

Electronic control was not identified as a failure category in any of the reports reviewed. This is generally because electronic control has received wide spread application in only the past three to four years.

A project observation regarding the electronic control unit (ECU) diagnostic capabilities of some vehicles was made. One of the papers reviewed (5) presents information regarding the use of this feature in the detection of emission related defects.

While information is not specific, it appears that this feature is useful only in detecting a limited number of total operational failures. For example, the coolant sensor of vehicle 17 was well out of calibration, but not detectable by the computer because it was not open or short circuited. The out of specification and fixed dwell of the carburetor solenoid on vehicle 21 is a failure that apparently could only be detected if the solenoid was open or grounded.

SECTION 6

ANALYSIS

A description of the various stages of the project has been presented in previous sections of this report. This section presents a summary and comparison of the data.

COMPARISON WITH STANDARDS

Every vehicle procured for this project was failing one or more of the emission standards when tested at the ARB emissions laboratory. Upon receipt at OEI, some adjustments and repairs were performed before the baseline tests were accomplished. One vehicle passed all three standards at its baseline, so it was aborted from the project. Two vehicles (13 and 24) were failing all three standards at their baseline. Upon completion of the inspections and repairs on eighteen vehicles, six were passing all three standards and two more (17 and 21) were failing marginally (10% and 5% over standard respectively).

Table 4 lists the pass/fail occurrences by vehicle number as a percentage of standard for the appropriate model year. There were a total of 29 occurrences of failure to meet standards out of a possible 54. This was reduced to 14 failures after completion of inspection and repairs. Improvement was obtained in all but four of the original 29 failure occurrences. One vehicle (20) was failing NOx at the baseline and failing HC at the final test. The HC failure was due to three cold stalls; a driveability problem rather than an emission component problem.

EMISSONS IMPROVEMENT

The emission levels obtained from the CVS-II baseline test were compared with the final emission levels. These results are presented in Tables 5, 6 and 7 for the total fleet, by model year and by manufacturer respectively. Two of the vehicles (5 and 6) were not included in the averages because the final test fuel economy values were higher than would be normally expected for these vehicles. A low CO_2 value would seem to indicate an exhaust collection leak which was not detected at the time of the test. The data points were therefore treated as statistical outliers and are shown only for information purposes. They are not included in either the baseline or final averages.

TABLE 4

PASS/FAIL AS A PERCENTAGE OF STANDARD

Vehicle No.	Abort	Baseline Fail HC	Baseline Fail CO	Baseline Fail NOx	Pass All 3	Final Fail HC	Final Fail CO	Final Fail NOx	Remarks
1		147			X				
2	X								Low Compression
3	X								Low Compression
4		142	116		X				
5		212		243		149			
6				128	X				
7		269	180		X				
8	X								Lead Contamination
9	X								Lead Contamination
10	X								Lead Contamination
11				138				132	
12				126				113	
13		153	140	123	X				
14		262	318			115			
15				134	X				
16		150		125		128		132	
17				128				110	
18	X								Passed Baseline
19		184				128			
20				130		150			3 Cold Stalls (Final)
21		135	197				105		
22		123		136		143		144	
23		166				150			
24		190	199	137		216	161		
24	6	12	6	11	6	7	2	5	Total Occurrences
133%	-	67	33	61	33	39	11	28	% of Tested Vehicles

TABLE 5

EMISSIONS IMPROVEMENT - BY VEHICLE NUMBER

				HC		CO		NOx		MPG*	
YEAR	VEH.	MFG.	ODOM	BASELINE	FINAL	BASELINE	FINAL	BASELINE	FINAL	BASELINE	FINAL
1980	1	GM	10,721	0.601	0.367	6.247	3.390	0.947	0.772	17.962	17.691
1981	4	Chry	17,025	0.583	0.227	8.147	3.115	0.687	0.640	20.778	21.562
1979	5**	Ford	27,693	0.868	0.612	5.212	3.767	3.644	1.527	12.538	16.776
1980	6**	GM	22,104	0.228	0.194	4.191	3.354	1.281	1.031	23.227	30.872
1980	7	Fgn	31,703	1.102	0.137	16.232	1.483	0.776	0.853	28.752	28.504
1980	11	Ford	9,730	0.246	0.223	1.995	1.549	0.969	0.922	18.287	18.543
1980	12	Fgn	28,283	0.177	0.202	2.892	2.709	1.256	1.131	24.630	24.426
1980	13	GM	10,496	0.629	0.297	12.584	4.284	1.228	0.337	14.027	14.787
1980	14	Ford	26,136	1.075	0.470	28.618	5.036	0.291	0.659	15.973	19.397
1981	15	Fgn	18,636	0.227	0.224	2.290	2.397	0.941	0.747	30.064	27.916
1980	16	Ford	26,212	0.614	0.526	3.038	3.299	1.254	1.324	16.766	16.194
1980	17	GM	16,985	0.265	0.345	5.438	5.786	1.278	1.097	18.091	18.214
1980	19	GM	22,951	0.756	0.526	8.169	8.353	0.990	0.862	15.547	15.269
1980	20	GM	28,083	0.267	0.616	6.791	6.702	1.299	0.718	21.619	19.609
1980	21	GM	30,915	0.553	0.366	17.723	9.474	0.944	1.039	20.791	20.496
1979	22	Fgn	43,144	0.504	0.587	5.070	4.874	2.034	2.163	16.598	16.249
1980	23	Ford	25,428	0.679	0.615	5.747	4.395	0.670	0.611	14.666	15.252
1979	24	GM	31,751	0.780	0.887	17.930	14.520	2.050	0.969	12.288	12.713
Fleet		Avg		0.564	0.413	9.307	5.085	1.101	0.928	19.177	19.176
		% Chg			-26.77%		-45.36%		-15.71%		-0.01%

* Arithmetic Mean Used for Average MPG.

** Final Test Invalidated Due to Suspected Exhaust Collection Leak. Baseline and Final Not Included in Average.

TABLE 6

EMISSIONS IMPROVEMENT - BY MODEL YEAR

				HC		CO		NOx		MPG*	
YEAR	VEH.	MFG.	ODOM	BASELINE	FINAL	BASELINE	FINAL	BASELINE	FINAL	BASELINE	FINAL
1979	5**	Ford	27,693	0.868	0.612	5.212	3.767	3.644	1.527	12.538	16.776
	22	Fgn	43,144	0.504	0.587	5.070	4.874	2.034	2.163	16.598	16.249
	24	GM	31,751	0.780	0.887	17.930	14.520	2.050	0.969	12.288	12.713
		Avg.		0.642	0.737	11.500	9.697	2.042	1.566	14.443	14.481
		% Chg.			+14.80%		-15.68%		-23.31%		+0.26%
		Std.			0.41		9.0		1.5		
1980	1	GM	10,721	0.601	0.367	6.247	3.390	0.947	0.772	17.962	17.691
	6**	GM	22,104	0.228	0.194	4.191	3.354	1.281	1.031	23.227	30.872
	7	Fgn	31,703	1.102	0.137	16.232	1.483	0.776	0.853	28.752	28.504
	12	Fgn	28,283	0.177	0.202	2.892	2.709	1.256	1.131	24.630	24.426
	13	GM	10,496	0.629	0.297	12.584	4.284	1.228	0.337	14.027	14.787
	14	Ford	26,136	1.075	0.470	28.618	5.036	0.291	0.659	15.973	19.397
	16	Ford	26,212	0.614	0.526	3.038	3.299	1.254	1.324	16.766	16.194
	17	GM	16,985	0.265	0.345	5.438	5.786	1.278	1.097	18.091	18.214
	19	GM	22,951	0.756	0.526	8.169	8.353	0.990	0.862	15.547	15.269
	20	GM	28,083	0.267	0.616	6.791	6.702	1.299	0.718	21.619	19.609
	21	GM	30,915	0.553	0.366	17.723	9.474	0.944	1.039	20.791	20.496
	23	Ford	25,428	0.679	0.615	5.747	4.395	0.670	0.611	14.666	15.252
		Avg.		0.611	0.406	10.316	4.992	0.994	0.855	18.984	19.077
		% Chg.			-33.55%		-51.61%		-13.98%		+0.49%
		Std.			0.41		9.0		1.0		
1981	4	Chry	17,025	0.583	0.227	8.147	3.115	0.687	0.640	20.778	21.562
	11	Ford	9,730	0.246	0.223	1.995	1.549	0.969	0.922	18.287	18.543
	15	Fgn	18,636	0.227	0.224	2.290	2.397	0.941	0.747	30.064	27.916
		Avg		0.337	0.225	4.144	2.354	0.866	0.770	23.043	22.674
		% Chg.			-33.23%		-43.19%		-11.09%		-1.60%
		Std.			0.41		7.0		0.7		

* Arithmetic Mean Used for Average MPG
** Final Test Invalidated Due to Suspected Exhaust Collection Leak. Baseline and Final Not Included in Average.

TABLE 7

EMISSIONS IMPROVEMENT - BY MANUFACTURER

YEAR	VEH.	MFG.	ODOM	HC BASELINE	HC FINAL	CO BASELINE	CO FINAL	NOx BASELINE	NOx FINAL	MPG* BASELINE	MPG* FINAL
1981	4	Chry	17,025	0.583	0.227	8.147	3.115	0.687	0.640	20.778	21.562
		% Chg			-61.06%		-61.77%		-6.84%		+3.79%
1980	7	Fgn	31,703	1.102	0.137	16.232	1.483	0.776	0.853	28.752	28.504
1980	12	Fgn	28,283	0.177	0.202	2.892	2.709	1.256	1.131	24.630	24.426
1981	15	Fgn	18,636	0.227	0.224	2.290	2.397	0.941	0.747	30.064	27.916
1979	22	Fgn	43,144	0.504	0.587	5.070	4.874	2.034	2.163	16.598	16.249
		Avg		0.503	0.288	6.621	2.866	1.252	1.224	25.011	24.274
		% Chg			-29.82%		-56.71%		-2.24%		-2.95%
1979	5**	Ford	27,693	0.868	0.612	5.212	3.767	3.644	1.527	12.538	16.776
1980	11	Ford	9,730	0.246	0.223	1.995	1.549	0.969	0.922	18.287	18.543
1980	14	Ford	26,136	1.075	0.470	28.618	5.036	0.291	0.659	15.973	19.397
1980	16	Ford	26,212	0.614	0.526	3.038	3.299	1.254	1.324	16.766	16.194
1980	23	Ford	25,428	0.679	0.615	5.747	4.395	0.670	0.611	14.666	15.252
		Avg		0.654	0.459	9.850	3.570	0.796	0.879	16.423	17.347
		% Chg			-29.82%		-63.76%		+10.43%		+5.63%
1980	1	GM	10,721	0.601	0.367	6.247	3.390	0.947	0.772	17.962	17.691
1980	6**	GM	22,104	0.228	0.194	4.191	3.354	1.281	1.031	23.227	30.872
1980	13	GM	10,496	0.629	0.297	12.584	4.284	1.228	0.337	14.027	14.787
1980	17	GM	16,985	0.265	0.345	5.438	5.786	1.278	1.097	18.091	18.214
1980	19	GM	22,951	0.756	0.526	8.169	8.353	0.990	0.862	15.547	15.269
1980	20	GM	28,083	0.267	0.616	6.791	6.702	1.299	0.718	21.619	19.609
1980	21	GM	30,915	0.553	0.366	17.723	9.474	0.944	1.039	20.791	20.496
1979	24	GM	31,751	0.780	0.887	17.930	14.520	2.050	0.969	12.288	12.713
		Avg		0.550	0.486	10.697	7.501	1.248	0.828	17.189	16.968
		% Chg			-11.64%		-29.88%		-33.65%		-1.29%

* Arithmetic Mean Used for Average MPG.

** Final Test Invalidated Due to Suspected Exhaust Collection Leak. Baseline and Final Not Included in Average.

The effectiveness of the repairs for the fleet was significant in that HC, CO and NOx were reduced by 27%, 45% and 16% respectively and at the same time fuel economy was unchanged.

The effectiveness by model year was considerably more varied. Emission level reductions were obtained for all pollutants and model years except HC for the two 1979 model year vehicles included in the average. The average of the two 1979 model year vehicles was failing for all three pollutants, even with CO and NOx reductions of 16% and 23%. The final test average of eleven 1980 model year vehicles was passing for all three pollutants. The three 1981 vehicle final test average was passing HC and CO by considerable margins, but was failing NOx by 10%. The reductions obtained for the 1981 model year were 33%, 43% and 11% respectively.

The manufacturer profile consisted of Chrysler, Foreign, Ford and GM. All manufacturer's fleets showed improvements in emissions levels, except for NOx in the Ford fleet. That increase was due primarily to one vehicle (14) that was grossly failing CO on the baseline, contributing to a very low NOx level. The correction reduced CO to below standard and while increasing NOx, the level was still well below standard.

COMPONENTS AND ADJUSTMENTS

Components that were tested and found to be out of specification were replaced with new parts obtained from the dealer parts network of the appropriate vehicle manufacturer. In a few cases, replacement components were not readily available, so a repair or adjustment was made, or no action was taken. A description of the actions performed are included in Appendixes B and C. Figure 1 presents a matrix of the vehicles versus problems found.

A summary listing of the problems located is presented in Table 8. Due to the fact that the terminology used by the various manufacturers is not standard, some general terminology and functional grouping is necessary. Some components are unique to a specific manufacturer and engine family so the total vehicles equipped is not always 18. The diagnostic indicator function is not an emission component but is included in the problem summary table due to the significance of its potential impact on identifying or overlooking failed emission components.

	TUNEUP PARAMETERS					TEMPERATURE MANAGEMENT			
VEH.	CURB IDLE	HIGH IDLE	TIMING	SPARK PLUGS	IDLE CO	THERMOSTAT	COOLANT SENSOR	AIR SENSOR	COLD WEA. MODULATOR
1	70 Lo, Adj		2°Ret, Adj	Narrow Adj, 1 Bad Replaced		Open Early, Replaced			
4									
5						Interm. Stuck Open, Replaced			
6		400 Lo, Adj	2°Ret, Adj						
7			2°Adv, Adj	Heat Rng, Replaced	7% Adj to 2.5%				
11						Open Late, Replaced			
12					Adj with Clean Inj				
13		700 Lo, Adj	4°Ret, Adj	Fouled, Replaced					
14				Wide, Adj		Open Early, Replaced			
15	100 Lo, Adj		2°Ret, Adj	Wide, Adj					
16			3°Ret, Adj						
17			5°Ret, Adj	Narrow, Adj		Stuck Closed, Replaced	Bad, Replaced		
19						Open Late, Replaced			
20						Open Early, Replaced			
21								Hose Off Correct	
22				Wide, Adj	Lean, Richen				
23		100 Lo, Adj		Narrow, Adj					Bad, Replaced
24			8°Ret, Adj			Open Late, Replaced	Bad, Replaced		

NOTE: Vehicles 2, 3, 8, 9, 10 and 18 were aborted.

FIGURE 1. VEHICLE PROBLEM MATRIX

	---IGNITION----		--------ELECTRONIC CONTROL---------				--------------AIR/FUEL CONTROL--------------				
VEH. NO.	ADVANCE	WIRES	ECU	DIAGNOS INDIC.	O_2 SENSOR	ENRICH. SOLENOID	FUEL INJECT	CARBURETOR	CHOKE	AIR FILTER	CAT CONVTR
1			Bad, Repl.	None/ Wrong		Lo Dwell, Adj					
4								Bad, Replaced			
5								Adj Bad, Corrected			
6			Bad, Repl.		Bad, Replaced			Adj Bad, Corrected			
7			Susp. Repl.					Rich Off Idle, Replaced			Eff Lo, Replaced Pellets
11											
12					Suspect, No Action		Dirty, Cleaned				
13				None	Loose, Tighten	Lo Dwell, Adj			Wrong Setting Adjust	Dirty, Replaced	Suspect, Replaced Pellets
14			Bad, Repl.								
15											
16											Suspect, No Action
17		4 Loose, Reconnect		None							
19				None							
20				None/ Wrong		Lo Dwell, Adj Carb		Adj Bad, Corrected			
21				None		Fixed Dwell, Hose Off, Corrected					
22							Lean, Richen				
23	Weight Stuck, Lube										
24							Suspect, Not Testable				

NOTE: Vehicles 2, 3, 8, 9, 10 and 18 were aborted.

FIGURE 1. VEHICLE PROBLEM MATRIX (Continued)

	VACUUM MANAGEMENT								EGR	
VEH. NO.	HOSE ROUTING	VAC. LEAK	TEMP/VACUUM SWITCH DISTRIB.	EGR/EFE	PURGE	VACUUM DEVICE REG. VLV	SW VLV	DELAY VLV	VALVE	POSIT SENSOR
1	Error, Correct			High, Replaced						
4										
5										Bad, Replaced
6										
7										
11										
12										
13										
14			2 Broke, Replaced							
15			Bad, Replaced	Bad, Replaced	Bad, Replaced		Bad,	Replaced		
16						Bad, Replaced				
17				High, Replaced					Bolts Loose, Tightened	
19			Bad, Not Avail.	Bad, Not Avail.	Bad, Replaced					
20	Off & Kinked, Correct	EGR Block, File					Low, Adj			
21	Off, Correct		Lo Temp, Replaced				Bad, Not Avail.			
22			Lo Temp, Replaced							
23								Backward, Correct		
24			Broke, Replaced						Shaft Worn Replaced	

NOTE: Vehicles 2, 3, 8, 9, 10 and 18 were aborted.

FIGURE 1. VEHICLE PROBLEM MATRIX (Continued)

TABLE 8

PROBLEM SUMMARY

CATEGORY	COMPONENT/PARAMETER	TOTAL EQUIPPED	NO. OF PROBLEMS	% OF TOTAL
Tuneup Parameters	Curb Idle	18	2	11
	High Idle	18	3	17
	Basic Timing	18	8	44
	Spark Plugs	18	8	44
	Idle CO	18	3	17
Temperature Mgmt.	Thermostat	18	8	44
	Coolant Sensor	16	3	19
	Air Sensor	16	1	6
	Cold Weather Modulator	5	1	20
Vacuum Managment	Hose/Routing	18	3	17
	Vac Leak	18	2	11
	Distributor TVS	18	6	33
	EGR/EFE TVS	16	4	25
	Purge TVS	18	2	11
	Vac Regulator Valve	5	1	20
	Vac Switching Valve	4	3	75
	Vac Delay Valve	18	1	6
Exhaust Gas Recirculation	EGR Valve	16	2	13
	Position Sensor	1	1	100
Ignition	Advance	18	1	6
	Wires	18	1	6
Electronic Control	Electronic Control Unit	16	4	25
	Diagnostic Indicator	7	6	86
	O_2 Sensor	16	3	19
	Enrichment Solenoid	7	4	57
Air/Fuel Control	Fuel Injection	3	3	100
	Carburetor	15	5	33
	Choke	15	1	7
	Air Filter	18	1	6
Catalytic Converter	Catalyst	18	3	17

A ranking of the top problem components/parameters by occurrence versus percent of total reveals the following:

OCCURRENCE	% OF TOTAL
Basic Timing (8)	EGR Position Sensor (100)
Spark Plugs (8)	Fuel Injection System (100)
Thermostat (8)	Vac Switching Valve (75)
Distributor TVS (6)	Enrichment Solenoid (57)
Carburetor/Adjust (5)	Thermostat (44)
EGR/EFE TVS (4)	Basic Timing (44)
Enrichment Solenoid (4)	Spark Plugs (44)
ECU (4)	Distributor TVS (33)
	Carburetor/Adjust (33)

As has been discussed before, it is not always possible to determine the specific effect of the replacement, repair or adjustment of an individual emission system component or parameter for the vehicles tested in this project. It is however possible to review the CVS emissions data presented in Table 2 and identify those changes that had a marked effect on one or more emissions levels. The repairs that are major contributors to emissions improvement appear to be:

REPAIR	POLLUTANTS	VEHICLE
ECU Replaced	HC, CO	1
Carb Replaced	HC, CO	4
New O_2 Sensor, Carb Adjusted	HC, CO, NOx	5
Carb and Catalyst Replaced	HC, CO	7
Catalyst Replaced	HC, CO, NOx	13
ECU Replaced	HC, CO	14
Carb Adjusted	HC (up), CO, NOx	20
TVS, Connect Vac Hose	HC, CO	21
Thermostat, EGR, TVS, Coolant Sensor	NOx	24

Of the four electronic control unit (ECU) replacements, two vehicles (1 and 14) showed significant improvements in HC and CO. A third replacement (vehicle 5) was not so significant, even when the ECU calibrator was also replaced. The fourth replacement (vehicle 6) had no significant effect, even with the O_2 sensor replaced.

Five vehicles had carburetor problems with two receiving OEM replacement carburetors. The carburetor of vehicle 4 had an internal leak visible through the top of the carburetor. It was not related to a factory service bulletin regarding the fuel inlet valve. The second carburetor replacement (vehicle 7) was due to a rich off-idle condition. The remaining three vehicles required a change of normally factory sealed adjustment screws. Two of the vehicles (5 and 20) showed emissions improvements, although the O_2 sensor was also replaced for vehicle 5 at the same time. Vehicle 20, when adjusted to specification, demonstrated cold start problems that likely was the cause for an increase in the HC emission level. The CO level was also higher than might otherwise be expected, based on the stabilized and hot start portions of the emissions test. The other vehicle (6) was initially found to have the carburetor idle adjustment anti-tamper plug removed, but the adjustment was within specification. The adjustments were rechecked and changed slightly after replacement of the ECU and O_2 sensor. However, the improvements obtained are suspect due to a large drop in the CO_2 level. This drop would seem to indicate a possible leak in the exhaust collection system. This drop was not identified until after the vehicle had been returned to its owner.

The pellets were replaced in the catalytic converter of two vehicles. The carburetor of vehicle 7 had been found to be defective and was replaced (see above). The heavy load on the catalyst apparently caused its deterioration. Replacement of the catalyst confirmed the repair of the primary problem, the carburetor. For vehicle 13, the catalyst was not suspected either as a result of ARB or OEI catalyst efficiency testing. The repairs resulting from the calibration inspection were not considered significant enough to correct the high baseline emission levels for all three pollutants, so the catalyst pellets were replaced. A hot start CVS test indicated that the combination of repairs had been effective. This was validated by the final cold start CVS-II test.

The catalytic converter system on a third vehicle (16) consists of a converter in each of two exhaust pipes that both feed into a single converter. The converter efficiency test of the three units gave values that were inconclusive. Replacement of all three converters was determined to be outside the scope of the project, so no action was taken.

The other two vehicles (21 and 24) with significant improvements in emissions had more than one repair performed. Since the loose vacuum hose for vehicle 21 contributed to a malfunction of the carburetor enrichment solenoid, its repair apparently resulted in the large CO reduction. This could also have contributed to a reduction in HC, although replacement of a 3-port distributor thermal vacuum switch may have assisted. The replacement of the EGR valve and three temperature and vacuum management components likely contributed to the NOx reduction for vehicle 24. The electronic fuel injection system for this vehicle is the suspected cause of the CO and HC failures. An unavailable piece of special test equipment was necessary to confirm this suspicion, so no action could be taken.

A similar review of Table 2 indicates that correction of the high occurrence tuneup parameter and temperature and vacuum management problems did not have a large effect in lowering emission levels. This is clouded somewhat in that timing and spark plug repairs were generally completed before the baseline emissions tests were performed. An ARB comparison of emission results for their last test to OEI's baseline test might provide some information about the effectiveness of these repairs. The difficulty with this comparison would include the use (and potential service) of the vehicle between the two test facilities and variability between tests and between emission laboratories.

APPENDIX A
Vehicle Descriptions

VEHICLE DESCRIPTION

Vehicle No. 1

Year:	1980	VIN:	1W19AAR432293
Make:	Chevrolet	Engine Family:	04E2MCR2
Model:	Malibu	Displacement:	231 CID
Trans:	Automatic	Carburetor:	1 x 2v
Odom:	10,721	License No.:	1ANR741

Vehicle No. 2 (Aborted-Low Compression)

Year:	1980	VIN:	81A0036045
Make:	Audi	Engine Family:	4000CL
Model:	4000	Displacement:	97 CID
Trans:	4 Speed Manual	Carburetor:	FI
Odom:	41,349	License No.:	701ZFE

Vehicle No. 3 (Aborted-Low Compression)

Year:	1981	VIN:	------------112152
Make:	Dodge	Engine Family:	BCR2.2V2HU8
Model:	Aries	Displacement:	2.2L
Trans:	4 Speed Manual	Carburetor:	1 x 2v
Odom:	23,663	License No.:	1BPH080

Vehicle No. 4

Year:	1981	VIN:	------------145205
Make:	Dodge	Engine Family:	BCR2.2V2HU8
Model:	Aries	Displacement:	2.2L
Trans:	Automatic	Carburetor:	1 x 2v
Odom:	17,025	License No.:	1BTN432

Vehicle No. 5

Year:	1979	VIN:	F9J76H124278F
Make:	Ford	Engine Family:	BV2TT95
Model:	Country Squire Wagon	Displacement:	5.8L
Trans:	Automatic	Carburetor:	1 x 2vv
Odom:	27,693	License No.:	324WZN

Vehicle No. 6

Year:	1980	VIN:	4C375AW287214
Make:	Buick	Engine Family:	02X2NC
Model:	Skylark	Displacement:	2.5L
Trans:	Automatic	Carburetor:	1 x 2v
Odom:	22,104	License No.:	DJM FIC

Vehicle No. 7

Year:	1980	VIN:	FA4US-640670
Make:	Mazda	Engine Family:	OUCP
Model:	GLC	Displacement:	86.4 CID
Trans:	4 Speed Manual	Carburetor:	1 x 2v
Odom:	31,703	License No.:	309ZYX

Vehicle No. 8 (Aborted-Lead Contamination)

Year:	1981	VIN:	JP3BE3422BU500969
Make:	Plymouth	Engine Family:	BMT1.42BC3
Model:	Champ	Displacement:	86.0 CID
Trans:	4 Speed Manual	Carburetor:	1 x 2v
Odom:	12,858	License No.:	1CAG314

Vehicle No. 9 (Aborted-Lead Contamination)

Year:	1981	VIN:	JP3BD4370BY800475
Make:	Plymouth	Engine Family:	6V2BC9
Model:	Sapporo	Displacement:	155.9 CID
Trans:	Automatic	Carburetor:	1 x 2v
Odom:	18,617	License No.:	1BIM279

Vehicle No. 10 (Aborted-Lead Contamination)

Year:	1980	VIN:	1M24JA5903512
Make:	Plymouth	Engine Family:	G1-C
Model:	Champ	Displacement:	1.4L
Trans:	4 Speed Manual	Carburetor:	1 x 2v
Odom:	18,615	License No.:	HEWITT1

Vehicle No. 11

Year:	1981	VIN:	1FABP27AXBG1211097
Make:	Ford	Engine Family:	2.3AX
Model:	Granada	Displacement:	2.3L
Trans:	Automatic	Carburetor:	1 x 2v
Odom:	9,731	License No.:	1BPR101

Vehicle No. 12

Year:	1980	VIN:	16A0395752
Make:	VW	Engine Family:	37CL
Model:	Jetta	Displacement:	97 CID
Trans:	5 Speed Manual	Carburetor:	F.I. CIS
Odom:	28,283	License No.:	595ZUS

Vehicle No. 13

Year:	1980	VIN:	1N47HAC128271
Make:	Chevrolet	Engine Family:	01Y4MCRZ
Model:	Caprice	Displacement:	5.0L
Trans:	Automatic	Carburetor:	1 x 4v
Odom:	10,496	License No.:	1BVY838

Vehicle No. 14

Year:	1980	VIN:	F0R02A157498F
Make:	Ford	Engine Family:	4V
Model:	Mustang	Displacement:	2.3L
Trans:	4 Speed Manual	Carburetor:	1 x 2v
Odom:	26,136	License No.:	1ASL253

Vehicle No. 15

Year:	1981	VIN:	JN1PN0656BM018283
Make:	Datsun	Engine Family:	BNS1.5V2AC7
Model:	310GX	Displacement:	90.8 CID
Trans:	4 Speed Manual	Carburetor:	1 x 2v
Odom:	18,636	License No.:	1BJC925

Vehicle No. 16

Year:	1980	VIN:	F0H93F610303F
Make:	Mercury	Engine Family:	4.2/5.0BJC
Model:	Cougar XR7	Displacement:	302 CID
Trans:	Automatic	Carburetor:	1 x 2v
Odom:	26,212	License No.:	368YHC

Vehicle No. 17

Year:	1980	VIN:	3R69AAM536472
Make:	Oldsmobile	Engine Family:	04E2MCRZ
Model:	Cutlass	Displacement:	3.8L
Trans:	Automatic	Carburetor:	1 x 2v
Odom:	16,985	License No.:	1ADK246

Vehicle No. 18 (Aborted-Passed Baseline)

Year:	1981	VIN:	------------001398
Make:	Datsun	Engine Family:	BNS 2.2T2AC2
Model:	King Cab Pickup	Displacement:	2.2L
Trans:	5 speed manual	Carburetor:	1 x 2v
Odom:	6,622	License No.:	1X44096

Vehicle No. 19

Year:	1980	VIN:	3Y69RAY102918
Make:	Oldsmobile	Engine Family:	03J4PCZ
Model:	Delta 88	Displacement:	5.7L
Trans:	Automatic	Carburetor:	1 x 2v
Odom:	22,951	License No.:	957YNU

Vehicle No. 20

Year:	1980	VIN:	1H115A6255357
Make:	Chevrolet	Engine Family:	02X2NC
Model:	Citation	Displacement:	2.5L
Trans:	Automatic	Carburetor:	1 x 2v
Odom:	28,084	License No.:	180ZYB

Vehicle No. 21

Year:	1980	VIN:	3B695AW198518
Make:	Oldsmobile	Engine Family:	02X2NC
Model:	Omega	Displacement:	2.5L
Trans:	Automatic	Carburetor:	1 x 2v
Odom:	30,915	License No.:	885YZU

Vehicle No. 22

Year:	1979	VIN:	WBA39910005333391
Make:	BMW	Engine Family:	BMW128.8
Model:	528I	Displacement:	2.7L
Trans:	4 speed manual	Carburetor:	F.I. L-Jetronic
Odom:	43,144	License No.:	192ZBQ

Vehicle No. 23

Year:	1980	VIN:	F0G87F103240F
Make:	Ford	Engine Family:	4.2/5.0BJC
Model:	Thunderbird	Displacement:	5.0L
Trans:	Automatic	Carburetor:	1 x 2v
Odom:	25,428	License No.:	734ZOK

Vehicle No. 24

Year:	1979	VIN:	6S69B99489602
Make:	Cadillac	Engine Family:	960JOUC
Model:	Seville	Displacement:	5.7L
Trans:	Automatic	Carburetor:	F.I. Port EFI
Odom:	31,751	License No.:	654XJL

APPENDIX B

Vehicle Problems Discovered

Vehicle No. 1 - 1980 Chevrolet Malibu

The subject vehicle was first checked to determine compliance with manufacturers tune-up specifications. Several discrepancies were noted:

- o Curb idle speed was 480 RPM (D), spec. is 550 RPM (D).
- o A/C kicker solenoid idle speed was 550 RPM (D), spec, is 620 RPM (D).
- o One of the vacuum hoses required to operate the thermac sensor and thermac motor was connected to an incorrect vacuum port in the carburetor.
- o Initial ignition timing was set at 13° BTDC at 550 RPM, spec. is 15° BTDC at 550 RPM.

At this point in the evaluation sequence a CVS-II emission test was conducted to act as a baseline and to provide additional diagnostic information. The vehicle did not pass CARB standards.

Continuing investigation revealed the following items:

- o The part numbers of all emission related items were checked and all parts were found to be correct.
- o All parts were installed correctly.
- o The carburetor was removed and all linkage settings, float level, choke angle, etc., were checked and found to be correct.
- o The coolant thermostat started to open at 175°F and was fully open at 190°F, spec. is 195°F fully open. This part was replaced with a new GM part which started to open at 185°F and was fully open at 193°F.

- The TVS control for EGR/EFE functions switched at 130°F, spec. is 120°F. A new GM switch was installed that switched at 122°F.
- The EGR valve was originally thought to be defective as it did not open fully on the test bench and was replaced with a new GM part, but further investigation revealed that this particular type of valve is dependent on exhaust gas back pressure to be activated completely. The original valve was then judged to be acceptable.
- The spark plugs were inspected and found to be the correct type as specified (AC R45TSX) but some of the electrode gaps were incorrect. Spec. is .060 in.

No. 1	.060
No. 2	.056
No. 3	.056
No. 4	.059
No. 5	.056
No. 6	.057

In addition, No. 4 plug showed heavy, dark deposits on the center procelain insulator area and therefore was replaced with a new AC R45TSX plug. As a precaution, all of the secondary (spark plug) leads were checked for resistance and found to be normal. Note that normal wear on spark plug electrodes tends to increase the gap and therefore it must be assumed that the gaps were not set prior to installation.

- The idle air bleed valve was not operating within specified limits. It is a cyclic system designed to indicate a duty cycle of 25°-35° dwell. The valve was indicating 10°-25°. The valve was reset. A rivet used to lock adjustment of the adjusting screw had not been installed, or had been previously removed.

At this point all contributing parameters appeared to be correct and a second CVS-II emission test was performed. The vehicle failed this test as well and the indications were that the air/fuel ratio was not correct throughout the test, a sign of a failure in the electronic control module (ECM.) However, the self diagnosis feature had not provided a visual indication of any fault until the end of this test.

At the conclusion of the test, however, the "check engine" light appeared for the first time. The ECM was then questioned according to instructions in the GM service manual and a failure code was indicated. The items indicated had been previously verified as good which left only the ECM itself as the failed component.

A replacement ECM corrected the air/fuel ratio problem and the vehicle passed a CVS-II test without difficulty.

Vehicle No. 2 - 1980 Audi 4000

A compression test on this vehicle during its initial inspection revealed that one of the four cylinders was low in compression. This problem is deemed a mechanical problem not repairable within the scope of this project. The vehicle was therefore dropped (aborted) from the program.

Vehicle No. 3 - 1981 Dodge Aries

This vehicle also had cylinder compression that was very low for one cylinder and a second that was lower than normal (85 and 110 pounds versus 150 pounds). The vehicle was also aborted from the program.

Vehicle No. 4 - 1981 Dodge Aries

All vehicle systems appeared to be intact and functional, but the first CVS-II test indicated a rich mixture or misfire condition (high HC and CO). Chrysler Service had released a bulletin covering a leaky fuel inlet valve (needle and seat) in the carburetor, but this condition was not present. The converter efficiency test showed several off scale readings of HC and one off scale reading of CO at the raw sample tap location, also indicating a rich or misfire condition. At this point, the carburetor was replaced with a new unit (P/N 4179163). The vehicle passed the next CVS-II test.

Vehicle No. 5 - 1979 Ford LTD Wagon

Initial visual inspection indicated that all systems were intact and routed correctly, however the carburetor, which appeared to be a new replacement unit, had been tampered with.

The venturi air bypass adjusting screw plug had been removed and the setting of the screw was not to specification. This was reset to specs before the initial test, but had little apparent effect. Functional checks of the complete EEC system showed little or no control activity when the engine should have been warmed up. The thermostat operated normally so the assumption was made that a single component (or components) of the system was malfunctioning. The EEC main body was replaced as was the calibrator (the chip that tailors EEC activity to the particular engine package involved), with no positive result. The emphasis was then shifted to testing/replacement of ECC input components. The quicker and least expensive test is often a direct replacement. The O_2 sensor, MAP sensor and coolant sensor (thermister) were all replaced (and tests run) without success. The EGR position sensor was found to be inoperative and was replaced, again without positive result. Finally the thermostat was removed and tested again. This test showed that the thermostat would stick in the open position about nine out of ten times as it was cycled hot/cold. This intermittant condition would not allow the engine to warm enough to actuate the thermister and the EEC. A replacement thermostat solved the problem. Parts actually failed were:

1. The thermostat (P/N D9AZ-8575-A)
2. The EGR position sensor.

Vehicle No. 6 - 1980 Buick Skylark

Three problems were noted during the preliminary inspection:

1. The initial spark timing measured 8° BTDC, spec. is 10° BTDC.

2. The fast idle speed was 400 RPM slow.

3. The antitamper plug was missing from the idle mixture screw. Idle CO was within specification.

Following the baseline test failure, the ECU was found to be defective. A retest showed some improvement but not a complete fix. Subsequent replacement of the O_2 sensor and a final carburetor adjustment restored the system to normal. Parts that had failed on this vehicle were:

1. The Electronic Control Unit (ECU)
2. The Oxygen (02) Sensor

Vehicle No. 7 - 1980 Mazda GLC

The 1980 Mazda GLC was inspected for basic tuneup parameters and for correct mechanical linkage and vacuum hose routing. All were found to be within specification except for the following:

Malperformance Found	Action
Timing advanced 2°	Reset to 5° BTDC
Idle CO 7%	Reset to 2.5%

A compression test yielded the following results:

Cylinder:	1	2	3	4
Compression:	165	140	150	130

A CVS-II Cold Start emissions test was then performed. Grossly elevated HC and CO emissions levels prompted a converter efficiency test. The CO efficiency varied from 33% to 49% while HC raw readings were offscale.

The thorough inspection of emission components revealed that spark plugs of an incorrect heat range had been installed (Bosch W175T30). They were replaced with standard plugs (NGK BP5ES) and a second CVS-II Cold Start test performed. Emission levels remained high so additional diagnosis was performed. A decision was made to replace the carburetor to correct an off-idle rich condition indicated by the high CO and HC levels at the 40 MPH and 50 MPH phases of the catalyst efficiency test.

Emissions remained high after the carburetor replacement. The presumption that the poor catalyst efficiency was due to the high HC and CO load caused by engine component deterioration was reevaluated. Since all calibrations were within specification, the remaining possibility was that the catalyst itself was deteriorated from normally heavy loading. The pellets in the catalyst were replaced and a confirmatory Hot Start CVS-I test was run. The results proved that the repair was effective.

At this point the CARB Project Engineer was notified and it was agreed that a final Cold Start CVS-II test should be performed. The results were well within standard for all pollutants.

Vehicle No. 8 - 1981 Plymouth Champ

The 1981 Plymouth Champ was inspected and found to be within specification for basic tuneup parameters and correct mechanical and vacuum hose routing. The vehicle was then prepared for the baseline CVS-II test and catalyst efficiency test.

The baseline test confirmed failure of both the HC and CO standards. During the conduct of the diagnostic inspection of emissions components, a lead test resulted in a value of 0.046 grams per gallon. After consultation with the CARB Project Engineer it was decided that a poisoned catalyst was likely the only cause of this vehicle deterioration. The vehicle was defined as an abort vehicle and returned to its owner with no further repair or testing.

Vehicle No. 9 - 1981 Plymouth Sapporo

The 1981 Plymouth Sapporo was initially tested for fuel lead content and found to have a level of 0.04 grams per gallon. After consultation with the CARB project engineer, the vehicle was defined as an abort vehicle and returned to its owner with no further repair or testing.

Vehicle No. 10 - 1980 Plymouth Champ

The 1980 Plymouth Champ likewise was found to have an excessive lead content in the fuel and was returned with no further repair or testing.

Vehicle No. 11 - 1981 Ford Granada

All parameters were found to be within specification for this 1981 Ford Granada. The baseline CVS-II test was run and NOx was found to exceed the standard by 38%. Further diagnosis determined that the only item not functioning properly was the coolant thermostat. It was not fully open until it reached 201°F while the specification calls for a fully open condition at 192°F. The replacement thermostat began to open at 180°F and was fully open at 193°F. An additional CVS-II test was run with no significant change to NOx, although all three pollutants were lower than the baseline test. The vehicle was returned to its owner after consultation with the CARB project engineer.

Vehicle No. 12 - 1980 VW Jetta

The preliminary inspection of this 1980 VW Jetta revealed three very dirty fuel injectors. All of the injectors were cleaned and the idle CO reset prior to the baseline CVS-II test. The results showed a high NOx failure. All emissions components were inspected and functionally checked and found to be within specification. It was determined that the procedure used to initially set idle CO was incorrect so it was reset using the proper procedure. Another CVS-II test was run with no significant improvement. The CARB project engineer determined that the vehicle should be returned to its owner with no further inspection or testing.

Vehicle No. 13 - 1980 Chevrolet Caprice

The 1980 Chevrolet Caprice was initially tested for lead content and found to have 0.088 grams of lead per gallon. Two additional tests were conducted for verification of the high level of lead. After consultation with the CARB project engineer, a decision was made to drain the fuel tank, refill it with unleaded fuel and continue testing. The loaded mode test performed at the CARB laboratory had indicated that the catalyst was still good.

Basic engine components and functions were than inspected with the following results:

Malperformance Found	Action Taken
Oxygen sensor loose	Retorqued
Timing at 0° BTDC	Advanced to spec. at 4° BTDC
Air filter very dirty	Replaced

A CVS-II cold start emissions test was then performed. Excessively high HC and CO emission levels indicated a converter efficiency test was necessary. The CO efficiency varied from 97% to 100% and HC readings were from 79% to 90%. NOx efficiency varied from 21% to 52% for the off-idle modes and increased through the catalyst at idle.

A further inspection of emission components was conducted and all items were found to be within the manufacturer's specifications, with the following exceptions:

Malperformance Found	Action Taken
Choke housing incorrect	Reset to factory specs.
Spark plugs fouled	Replaced
Freq. valve at 20° dwell	Reset to spec at 30° dwell
Cold fast idle at 1500 RPM	Reset to spec at 2200 RPM

The idle bleed air valve had been tampered with in that the anti-tamper plug had been removed. The dwell was reset as noted above using the instruction provided in the Mitchell Emission Control Service and Repair manual, page 181. The lean metering screw had also been tampered with, but the setting was within specification.

A compression test was performed with the following results:

Cylinder:	1	2	3	4	5	6	7	8
Compression:	150	150	140	145	150	150	155	145

After consultation with the CARB project engineer, the catalyst pellets were changed and 102 miles accumulated.

The values measured during the calibration inspection are included at the end of this report.

A Hot 505 and a second converter efficiency test were performed with HC readings between 89% and 94% and CO between 92% and 98%. A problem developed with the NOx analyzer during the conduct of the catalyst efficiency test. An 88% efficiency was obtained at idle. Again, the CARB project engineer was consulted and a final CVS-II was run. The results were well within standards for all pollutants.

Because of the deteriorated condition of the air cleaner and the spark plugs, there is some doubt as to whether the odometer reading is correct.

Vehicle No. 14 - 1980 Ford Mustang

The 1980 Ford Mustang engine components and functions were checked with the following results:

Malperformance Found	Action Taken
Spark plug gap @ .043 in.	Reset to spec. @ .035 in.

A baseline CVS-II test was then performed resulting in excessively high HC and CO emission levels.

The vehicle was further inspected to manufacturers specifications with the following results:

Malperformance Found	Action Taken
Thermostat @ 180° F	Replaced: P/N D9FZ-8575-A
No output from ECM to control valve.	ECM Replaced: P/N E0FZ-12A651-A
Two broken TVS switches	Replaced: P/N D8BZ-9D473-A P/N D7BZ-9D473-A

The TVS switches broke during removal for the calibration checks. Replacement of these switches and removal of the broken pieces required an additional day of mechanic labor.

After accumulation of 20 miles on the vehicle, a second CVS-II was performed. The HC emission level was still higher than allowed. The ARB engineer was consulted and a decision was made to accumulate at least 100 miles on the vehicle.

A converter efficiency test was performed. HC efficiency varied between 89% and 93% and CO readings ranged from 77% to 95%. NOx efficiency varied from 54% to 86%.

After 230 miles a third CVS-II was performed. The HC emission level was closer to the requirement but still failing. Further mileage accumulation would probably have brought the HC emission level into conformance. It was then decided that the vehicle would be returned without further testing.

Vehicle No. 15 - 1981 Datsun 310 GX

The initial inspection performed on this vehicle uncovered the following:

Malperformance Found	Action Taken
Ignition Timing @ 3 ^{o} BTDC	Reset to spec @ 5^{o} BTDC
Idle Speed @ 650 RPM	Reset to spec @ 750 RPM

A baseline CVS-II emissions test was performed with results indicating a failure of the NOx standard by about 25%. A complete inspection was then undertaken, with the following results:

Malperformance Found	Action Taken
Vacuum switching valve (Type B) not operational	Replaced (P/N 14955-M6710)
TVS switch out of spec	Replaced switch
Spark Plug Gap @ .046 in	Reset to spec @ .041 in.

The TVS switch was broken during removal. It was repaired by gluing the plastic parts back together and tested. The switch was found to be out of spec and was replaced with one that was within spec.

The speed detecting switch controlling the electrical signal to the replaced vacuum switching valve was tested and found to function the opposite of the calibration data given (see Appendix C). However, the vacuum switching valve functioned properly with this opposite configuration.

The bleed down time calibration of three vacuum delay valves was incorrectly tested due to a confusion in the way the specification was communicated. Instead of applying an unspecified vacuum and then timing against a specification of 20 $\pm$ 4 sec. (or 10 $\pm$ 2 sec), a vacuum of 20 in Hg (10 in Hg) was applied and timed against a specification of 4 seconds (2 seconds). Since the results were close to the "expected" value, the procedure was not questioned until the vehicle had been returned to its owner.

A compression test was performed and one cylinder was found to be a little low.

Cylinder	1	2	3	4
Compression, Dry	145	145	125	145
Compression, Wet	175	175	175	175

A second CVS-II emissions test was then performed and although the NOx level was above standards, normal rounding practice caused the level to be right at standard (0.747 = 0.7). A catalyst efficiency test was performed immediately after this CVS-II test. The results varied from 90% to 93% for HC and 88% to 98% for CO. NOx efficiency at idle was zero and varied between 14% and 48% for the loaded modes. It is suspected that the NOx analyzer was malfunctioning, so the data was considered unreliable.

Vehicle No. 16 - 1980 Mercury Cougar XR7

The initial inspection of the tuneup parameters revealed that the timing was out of specification.

Malperformance Found	Action Taken
Ignition Timing @ 3° BTDC	Reset to spec @ 6° BTDC

A compression test was performed, with the following results:

Cylinder	1	2	3	4	5	6	7	8
Compression	145	145	150	140	135	140	140	145

The initial CVS-II test revealed that the vehicle was failing both HC and NOx by 50% and 25% respectively. The vacuum regulator valve controlling vacuum to the distributor was not within specification so it was replaced.

Malperformance Found	Action Taken
Vacuum Regulator Valve	Replaced (P/N 090Z-9F490-A) out of spec.

An additional CVS-II was performed and HC and NOx were still failing by 28% and 32% respectively. Since all other calibrations were within specification, a catalyst efficiency test was performed. This vehicle is equipped with three catalysts, one each of the left and right front toe-boards and one at the center of the vehicle receiving exhaust from the other two. The analyzer recordings at idle for HC and NOx for the right front and center catalysts are considered invalid. The efficiencies varied considerably, with the higher efficiency generally produced at the heavier load for HC and NOx and the reverse for CO.

With the lead content higher than would normally be expected, and poor catalyst efficiencies, it is concluded that the catalysts are poisoned or that the carburetor had problems not detectable within the scope of the required inspections.

After consultation with the CARB project engineer, the vehicle was returned to its owner.

Vehicle 17 - 1980 Olds Cutlass

An initial inspection identified a large number of malperforming items.

Malperformance Found	Action Taken
Ignition Timing @ 10^{o} BTDC	Reset to spec. @ 15^{o}BTDC
Spark plug gap @ .040 in.	Reset to spec @ .060 in.
Spark plug wires 2, 4, 6 loose	Reconnected
EGR valve bolts hand tight	Retightened

The EGR valve showed signs of leakage at the flange where the loose bolts were found. The diagnostic check of long term memory in the ECM indicated that nothing was defective.

The initial CVS-II results showed a NOx failure 28% above standard. A converter efficiency test showed that the catalyst was in very good condition.

The detailed inspection of component calibrations revealed:

Malperformance Found	Action Taken
EFE/EGR TVS out of spec	Replaced (P/N 3033795)
Engine coolant sensor out of spec	Replaced (P/N 1-8993298)
Thermostat out of spec	Replaced (P/N 3041390)

An additional CVS-II test was performed revealing that NOx was still failing, though improved from 28% to 10% above standard. As a result of the changes, HC and CO were increased but were still well within standards. With calibrations and inspections within specification and the converter good, the CARB project engineer was consulted and the vehicle returned to its owner.

<u>Vehicle No. 18 - 1981 Datsun King Cab Pickup</u>

The initial inspection revealed:

Malperformance Found	Action Taken
Ignition Timing @ 3^{o} BTDC	Reset to spec @ 5^{o} BTDC

The vehicle was then given a CVS-II test and was found to pass all standards. The CARB project engineer was consulted and the decision was made to abort the vehicle from the project.

<u>Vehicle No. 19 - 1980 Olds Delta 88</u>

The initial inspection did not reveal any parameters out of specification, errors in vacuum routing, or mechanical problems.

An initial CVS-II test was performed that showed HC failing by more than 80% and CO and NOx near the limit of their standards. A comprehensive inspection of components and calibrations revealed the following:

Malperformance Found	Action Taken
Distributor TVS out of spec	None - Part only available from factory
Distributor - EGR TVS out of spec	None - Part only available from factory
Thermostat out of spec	Replaced (P/N 3041390)
Canister Purge TVS out of spec	Replaced (P/N 3046169)

The two parts available only from the factory would require at least five working days for delivery. After consultation with the CARB project engineer, it was decided to proceed. An additional CVS-II test was then performed, followed by a converter efficiency test. The CVS-II showed that even though improvements had been made in HC and NOx, the vehicle was still failing HC by 28%. The converter efficiency test revealed that HC was being converted properly.

The CARB project engineer was again consulted and it was decided to replace the pellets in the catalyst. The replacement pellets were not available, so it was requested that the existing pellets be removed, weighed and replaced. The weight and volume of the pellets were 1334.12 grams and 2590 ml respectively. This effort required the retention of the vehicle for an additional day and labor not normally performed. The additional effort was authorized by the CARB project engineer.

Vehicle No. 20 - 1980 Chevrolet Citation

The initial inspection showed all tune-up parameters to be at specification and all visible vacuum hoses properly routed and mechanical components properly connected.

A baseline CVS-II was performed that showed NOx to be failing by 30% above standard. A complete calibration inspection was undertaken, with the following results:

Malperformance Found	Action Taken
Vacuum hose to heated air inlet door off at carb.	Reattached prior to next CVS-II test.
Vacuum hose from decel valve to intake manifold too short and pinched closed at bend.	Replaced with longer hose.
Thermostat opened at 166°F.	Replaced with part open at 189°F.
Vacuum control switch "B" deactivation value marginally low	Part not available at dealer so no action taken.

The plot of the advance curves showed vacuum advance to be above the performance window at 21 in. Hg and centrifugal advance below the performance window at 4000 RPM. No action was taken. Carburetor solenoid dwell was found to be 5° to 20° at idle and 25° to 35° at 2500 RPM on a 60° scale, against a specification of 10° to 50°.

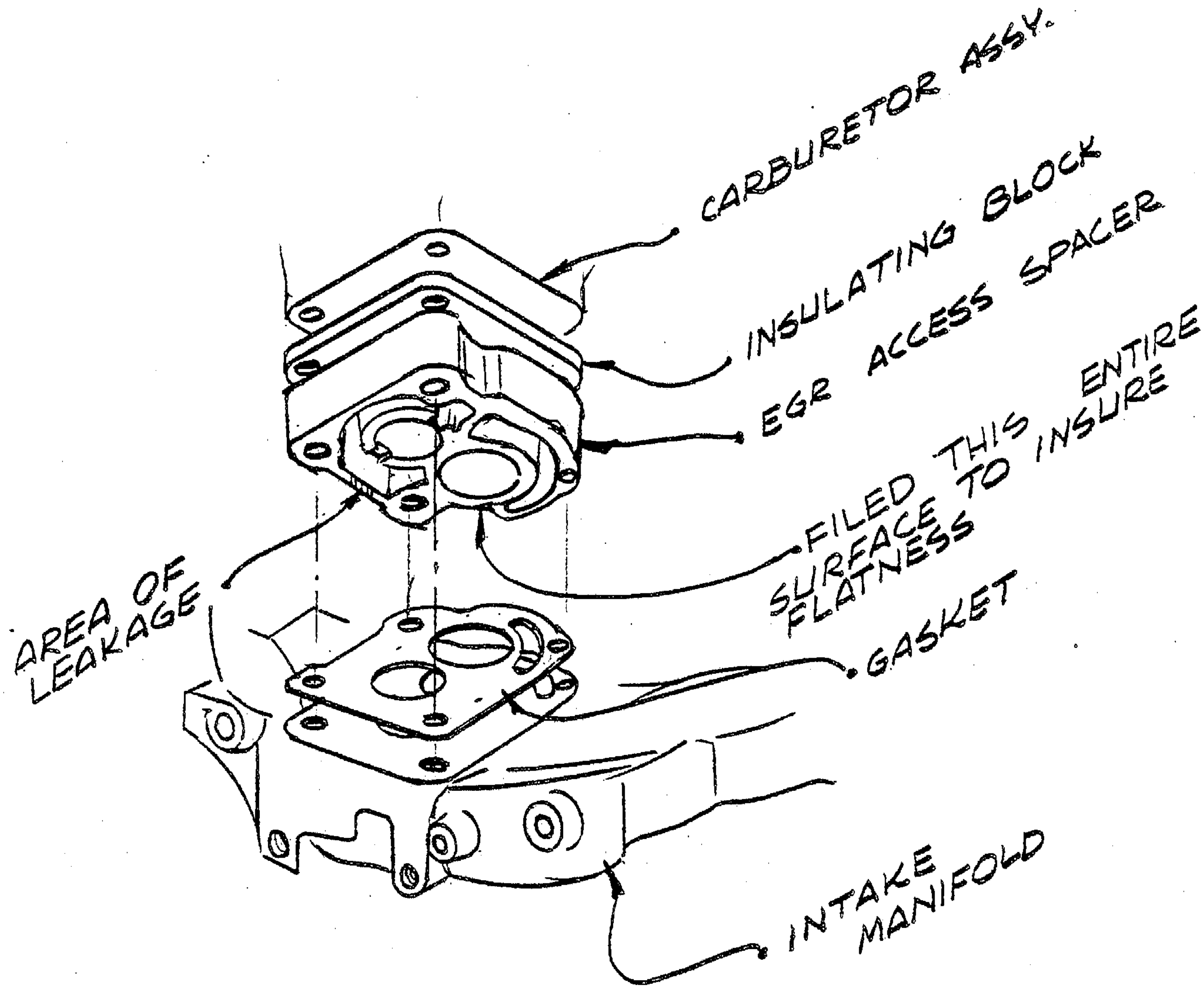
An additional CVS-II test was performed with the results showing an increase in HC, in CO (to 21% above standard) and reduction in NOx (to 6% above standard). A catalyst efficiency test was then run to ensure that the catalyst was working properly, which it was.

A number of calibration parameters and other items were double checked including carburetor solenoid dwell, EGR valve performance, O_2 sensor function and installation, vacuum hose connections, carburetor and intake manifold vacuum leaks and ECM part number.

The C-4 computer did not show any failure code in short term memory or when long term memory was connected. Stepping through the diagnostic procedure using a manufacturer shop manual resulted in a code 21 only, which is not applicable to the four cylinder engine. Codes 21 and 22 together should have been obtained.

An AFR test was then run and the data superimposed on the carburetor flow curve (see Appendix C). The results were generally outside the performance windows, on the lean side, for both the 10% and 90% duty cycles. The AFR results are an approximate though significant indication that there were problems in the carburetor.

After consultation with the CARB project engineer, it was decided to remove the carburetor, remove the adjustment plugs and check the carburetor adjustments. While the carburetor was off, the EGR block and intake manifold were also removed to check for any sign of vacuum leaks. There were no signs of leakage or cracks in the intake manifold. Figure B-1 shows a pictorial view of an area of suspected leakage. The base of the EGR block was filed to ensure flatness and the manifold and EGR block reinstalled using new gaskets.



	Olson Engineering, Inc.				
DRAWN JRM	SIZE A	FSCM NO.	DWG. NO. Figure B-1		REV. –
ISSUED 6-4-82	SCALE NONE		B-25	SHEET 1 OF 1	

The carburetor mixture settings (in turns from a lightly seated condition) were as follows:

Parameter	As Found	Bench Spec	On Car Adjustment
Idle Air Bleed	1½ turns	3 turns	3 turns
Lean Mixture	2¼ turns	2½ turns	4 turns
Idle Mixture	3½ turns	5 turns	4¼ turns
Rich Mixture	1¼ turns	No Spec	Unchanged

The carburetor solenoid dwell on completion of these adjustments was varying around a 25° dwell average at 700 RPM and around a 35° dwell average at 3000 RPM.

Another attempt was made without success to obtain the marginally low vacuum control switch "B". Since this is an adjustable switch with a sealed adjustment screw, the seal was broken and the switch adjusted. The result was:

Parameter	As Found	Spec	As Adjusted
Activation Value (vacuum decreasing)	4.3 in Hg	4.3-5.7 in Hg	5.2 in Hg
Deactivation value (vacuum increasing)	4.7 in Hg	4.8-6.2 in Hg	5.5 in Hg

A final CVS-II test was run to evaluate the effect of these changes. The vehicle was difficult to start at the beginning of the cold transient phase of the test and it stalled three times before the first acceleration. It demonstrated driveability problems throughout the first 200 seconds of the test. This problem is the expected reason for the failure to meet the HC standard on this final CVS-II test. The second and third bags of the CVS-II showed an improved HC when compared to the baseline.

CO and NOx were now well within standard. NOx was greatly improved in all three bags when compared to the baseline test. CO was improved in the first and third bags and was the same in the second bag.

At the request of the CARB engineer, the pellets were removed from the catalyst and checked for volume and weight. The volume was found to be 2630 ml and the weight was 1320 grams. These same pellets were put back into the catalyst chamber and a new plug installed.

Vehicle No. 21 - 1980 Oldsmobile Omega

The vehicle was found to have a higher than normal lead content (0.048 gram/gal.) in the gasoline as received. After consultation with the CARB project engineer, it was decided to retain the vehicle but first to drain the tank, refill with unleaded gasoline and accumulate approximately 100 miles. Upon initial inspection, it was found that the carburetor solenoid dwell was fixed at 5^{o}. All other parameters were within specification.

The baseline CVS-II test was then run and the vehicle was found to be failing HC (35%) and CO (97%). The calibration inspection revealed the following:

Malperformance Found	Action Taken
Three Port Distributor TVS out of spec	Replaced (P/N 3039246)
Vacuum control switch "B" deactivation value low	Part not available at dealer so no action taken.

A vacuum hose to the bimetal temperature sensor in the air cleaner was found to be disconnected. This was replaced and all other hose connections and routings verified. The carburetor solenoid dwell was then remeasured and found to be varying within a 15^{o} to 35^{o} range on a 60^{o} scale (against a specification of 10^{o} to 50^{o}).

The plot of the distributor advance curve shows that the centrigual advance was below the performance window at 4000 RPM. No action was taken. The vacuum advance curve was within the specification.

A second CVS-II test was run with improvement in HC to passing, CO to a marginal fail (5%) and NOx to a marginal pass. A converter efficiency test proved the catalyst to be good.

As with the Citation (Vehicle No. 20) the catalyst pellets were removed, checked for volume and weight and then put back into the catalyst chamber and resealed. The volume was 2640 ml and the weight was 1314 grams.

The vehicle was retained for two additional days while diagnosis continued on the Citation, with the expectation that the Omega might have a similar problem resulting in high CO. With no definitive answer in sight, it was decided by the CARB project officer to return the vehicle to its owner on the third day after its last test.

Vehicle No. 22 - 1979 BMW 528i

The vacuum hose routings were correct and the measured tuneup parameters were found to be within specification except:

Malperformance Found	Action Taken
Spark plug gap at 0.030 in.	Reset to spec at 0.028 in.
Idle mixture too lean (0.1% CO). Air flow meter plug missing	Adjust to 0.35% CO (Spec 0.2% to 0.8%)

The vehicle was then given a baseline CVS-II test. The results were a failure in HC (23%) and in NOx (36%).

The calibration inspection revealed:

Malperformance Found	Action Taken
Vacuum advance thermo-switch out of spec (104^{o}F vs. low spec of 107.6^{o}F)	None - per engineering decision that this was not a contributory cause.

The idle mixture was further richened to obtain a mid-spec reading of 0.5% CO even though the previous adjustment was within the acceptable range. The intent was to rule out any lean misfire condition.

A second CVS-II test was performed, with an improvement to NOx, although still failing (13%). HC was unchanged but CO dropped by 33% to well below standard.

A catalyst efficiency test was run followed by an AFR test. The catalyst efficiency test showed the catalyst was good. The 40 mph extra load NOx test data were questionable (28% efficiency) and were deleted. The AFR test was consistent except for a rich condition just off idle (10 mph) especially at 10% duty cycle.

The only item not within calibration was the vacuum advance thermoswitch so it was replaced with a new part. The new part was checked and found to open at 108^{o}F, the low end of the acceptable range. A final CVS-II test was run resulting in a deterioration in HC (failing by 43%), in CO (though still passing) and in NOx (failing by 44%). With all parameters and components within specification and after consultation with the CARB project engineer, the vehicle was released to its owner.

Subsequent to release of the vehicle, a review of the CO adjusting procedure contained within the application information provided by CARB and of service information published approximately six months later shows an inconsistency in procedure and specification. The procedure used by OEI was the one given in the application information. Both procedures are copied from the documents provided by CARB and are included with the calibration data in Appendix C.

Vehicle No. 23 - 1980 Ford Thunderbird

The initial inspection revealed some unusual information. Some factory information items had been manually modified and the carburetor was a different model than expected. The underhood emissions decal had been manually modified from EOSE-9C485-CA/BJD on the factory decal to EOSE-9C485-MA/BPG. The engine calibration number on the factory engine decal was C11N RO S25. This translates to a 0-11N-R00 calibration number. A mark that might be interpreted as a one (1) was inserted manually between the R and 0 on the decal, perhaps signifying a Revision 10 instead of Revision 0. The carburetor specified for Revision 0 is an E04E-9510-EA. The carburetor that was installed on the engine was an E04E-9510-VA. This was a new carburetor replaced as part of CARB activities prior to receipt by OEI. The VA carburetor is specified for a Revision 10 engine.

Since the basic parameters are the same specification for both Revision 0 and Revision 10, these were checked and corrected before the vehicle received its baseline test. The discrepancies were as follows:

Malperformance Found	Action Taken
Spark plugs gapped at 0.041 in. to 0.043 in.	Reset to spec at 0.050 in.
Fast idle speed 1400 RPM on cold start and increased to 2000 RPM at about 2 min.	TVS switch suspect - Replaced. Fast idle speed set to spec at 2100 on high step.

The baseline CVS-II test results showed HC to be failing by 66% above standard. CO and NOx were both well within standard. The calibration inspection was then completed and the following irregularities noted. The suspect TVS switch previously replaced was found to be within specification, as was the new one, so the old one was put back in the car.

Malperformance Found	Action Taken
Air Cleaner Cold Weather Modulator out of spec.	Replaced (P/N D5DZ-9E862-A)
Vac Delay Valve, Vac to Air Control Bypass Valve installed backward.	Corrected installation
Distributor Advance Weight Sticking	See Below

The centrifugal and vacuum advance curves were checked with the distributor in the car since the OEI distributor machine did not have the ability to sense the magnetic trigger (i.e. "point activity"). Both were below and above specification at several points on their respective curves (see Appendix C) . The results of the centrifugal advance test suggested sticking weights. The distributor was removed from the vehicle and one weight was found to be sticking due to an accumulation of rust. The weights were cleaned and lubed through the inspection hole in the plate. The plate attaching hole in the accuating arm of the vacuum advance unit was found to be elongated slightly, probably due to a lack of lubrication. Lubrication was applied.

The curves were rechecked and found to be consistently below specification for the centrifugal advance and shifted slightly higher on the upper half of the vacuum advance curve.

A new distributor assembly with vacuum advance unit was obtained and installed. The curves were again run. This time, the centrigual curve was consistently above specification while the vacuum advance curve was very similar to the old vacuum advance unit. An additional distributor assembly was only available through dealer channels with a one week delivery.

The procedural and equipment aspects of the method of plotting the two curves were reviewed. Some error could be induced in the vacuum advance curve obtained with the distributor in the car due to a centrifugal advance contribution caused by an increase in engine RPM as additional vacuum was applied. The RPM increase was on the order of 200 RPM above idle (i.e. about 800 RPM (N) max). The centrifugal advance curve was strictly a function of engine RPM since vacuum was disconnected and plugged for the test.

A modification was devised for the OEI Sun distributor machine to allow it to detect magnetic reluctance changes that signal plug firing.

The vacuum advance curve for the new distributor run on the modified distributor machine was within specification but a retest on the car showed it to be as far out of specification as before. The centrifugal advance curve on the new distributor however was out of specification both on the modified distributor machine and on the car.

The old distributor and vacuum advance unit were tested on the modified distributor machine. The vacuum advance curve was now on the low side but within the production gates. The centrifugal advance curve was within the production gates except for the point at 2500 distributor RPM, where it was 2+ degrees above the gate. The old distributor and vacuum advance assembly were reinstalled in the vehicle and the curves rechecked. The vacuum advance was measured on the high side but within the production gates. The centrifugal advance curve was also higher than the distributor machine curve except for the 5000 engine RPM (2500 distributor RPM) point. In the car, that point was now just at the high edge of the production gate.

The four significant distributor curves (the first, second, third and last) are included in Appendix C. A number of interim curves that were run will be maintained in the vehicle file.

With the distributor curves now as close to specification as possible (probably due to working in the lubrication and multiple disassembly/assembly actions), the tune-up parameters were again checked and the vehicle prepared for a final CVS-II test.

A catalyst efficiency test was not performed on this vehicle. It is equipped with three catalysts, making individual catalyst efficiency difficult to measure in a definitive manner. The exhaust emission levels for CO and NOx indicated a proper functioning of oxidation and reduction activities of the catalysts.

The results of the CVS-II showed an improvement in all three pollutants but HC was still failing by 50%. With all parameters and components within specification it was decided, after conferring with the CARB project engineer, to return the vehicle to its owner.

In preparing the vehicle to return it to its owner, a rough idle was detected that had not been noticed before. A vacuum leak was suspected. Manifold vacuum varied 18-20 in. Hg. All suspect areas were examined by spraying with carb cleaner. Some leakage was detected at the carburetor throttle shaft. The EGR valve shaft had a small leak. Inspection revealed that the shaft was slightly off-center, but still seating and functioning properly. The NOx levels support this. The largest discrepancy was with the intake manifold. It was found to be tightened to 12 ft. lbs. instead of a specificed 23 to 25 ft. lbs. It was retorqued to spec and in proper sequence. Manifold vacuum now varied 18-19 in. Hg and the idle was smoother though still a little rough. No additional emissions tests were performed.

Vehicle No. 24 - 1979 Cadillac Seville

Upon receipt, the vehicle was tested for lead content in the fuel tank, the basic tune-up parameters were checked and the vacuum hose routing and emission component installation verified. Some documentation indicated that this vehicle should be equipped with an AIR system. No sign of an air pump or other AIR system components was found. However, information received from the CARB provided verification that this engine family was not equipped with an AIR system.

Malperformance Found	Action Taken
Basic Timing Set at 2^{o} BTDC	Reset to spec at 10^{o} BTDC

The vehicle was then tested for baseline emissions and found to be failing all three standards by wide margins (90%, 99% and 37% high for HC, CO and NOx).

A Cadillac factory shop manual was obtained to supplement information provided by the CARB. Calibration tests were then performed to verify emission component operation within manufacturer specification. The following was found during the inspection.

Malperformance Found	Action Taken
EGR valve shaft excessively worn.	Replaced (P/N 17052743)
Thermostat open at higher temperature than spec.	Replaced (P/N 3041388)
Distributor thermal vacuum switch shattered during removal.	Replaced (P/N 3030975)
Coolant temperature sensor.	Replaced (P/N 1609968)
Basic timing at 3^{o} BTDC	See Below.

Timing was checked as a matter of procedure before beginning a check of the distributor advance curve. It was found to be different from the setting prior to the baseline emissions test. The distributor clamp was snug but not tightened to spec (18 foot pounds). It is not very probable that the distributor rotated, although the retarded timing from its previous setting would seem to indicate this. The equipment used to verify tuneup parameters is a Sun Diagnostic Computer, Model 2001. The mechanic used his own timing light to initially set the timing. His timing light, the Sun system timing light and a third timing light were then checked against each other and all found to give the same reading. This cross check is a normal OEI quality assurance practice, occurring approximately on a monthly basis. Timing was then reset to specification and the distributor advance curve developed and compared to specification. Centrifugal advance was found to be slightly below the production window at 1500 RPM and within the window at all other specified engine speeds and vacuums. No action was taken.

A specification was not provided for the coolant temperature sensor (same as air temperature sensor) so a resistance versus temperature curve provided in the shop manual was used. The coolant temperature sensor was considered not to be "--at a reasonable resistance for prevailing temperature--"* so it was replaced. The curve plots are included in Appendix C.

It was not possible to perform a number of calibration checks on the electronic fuel injection (EFI) system since this requires a special analyzer (J-25400). All of the visual inspections relative to the EFI that are listed on page 6C-63 of the Cadillac Service Manual were performed. The fuel pump pressure and fuel pressure regulator were checked and found to be within specification.

*1979 Cadillac Service Manual, Page 6C-79, Step 10

In order to obtain some idea of the functioning of the EFI, the oxygen sensor output was traced on a strip chart recorder for various steady-state speeds on a chassis dynamometer. The sensor was clearly cycling, indicating proper operation and ECU activity in providing rich and lean signal conditions to the fuel system. Enrichment was noted each time the speed was increased to the next higher level. A full rich condition was noted on the decel from 50 mph. A rich condition was also noted at idle due to an increase in pulse width. It appears that the system goes to an open loop condition on deceleration and at idle but information was not available to substantiate this.

A catalyst efficiency test was performed and the catalyst was found to be in good condition.

After completion of all of the calibration tests and inspections that were possible, the vehicle was prepared for a final CVS-II test.

The results showed a correction of the NOx problem to a level well below standard. The CO level was improved although still failing by 61%. The HC level degraded even further from 90% to 116% greater than standard. With no further checks possible, the CARB project engineer was notified and the vehicle was returned to its owner.

APPENDIX C

Calibration Inspection Results

ENGINE CALIBRATION DATA

Vehicle No. 1, 1980 Chevrolet Malibu - 04E2MCRZ

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
Fuel Pump Delivery Pressure	6441209	29.3 - 39.6 kPa	33.1 kPa	
Idle Speeds				
Curb		550 RPM in drive	480 RPM	Reset to spec.
A/C Solenoid Active		620 RPM in drive	600 RPM	Reset to spec.
Fast		2200 RPM in park	2200 RPM	
Carburetor Vac. Break Setting	17080495			
Front		$21^\circ \pm 2.5^\circ$	Not Recorded	Within spec.
Rear		$30^\circ \pm 3.5^\circ$	Not Recorded	Within spec.
Air Inlet System				
Fully Closed to Cold Air		30°F min.	32°F	
Fully Open to Cold Air		55°F max.	53°F	
Vac. Motor Full Travel		6.8 - 20.2 kPa	Not Recorded	Within spec.
Distributor Basic Timing	1110784	15°BTC @ 550 RPM	15°BTC @ 550 RPM	
Spark Plug Gap	R46TSX	0.060 in.	0.056 - 0.060 in.	Reset to spec. 1 plug replaced
EGR Ported Vacuum Signal	3033795			
Activation		$120 \pm 3^\circ$F	122°F	
Deactivation		110°F min.	111°F	
EFE Manifold Vacuum Signal	3033795			
Activation		$120^\circ \pm 3^\circ$F	130°F	Replaced
Deactivation		110°F min.	112°F	
EFE Actuator Vacuum	460734			Functional Check OK
Air Control Valve Relief Pressure	17062994	56.5 - 72.4 kPa	70 kPa	
Manifold Air Check Valve	22017158			Functional Check OK
EGR Valve	17062861			Functional Check OK

Vehicle No. 1, (Page Two)

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
EFE Valve	5233320			
Vac. Sig. to Close		1" Hg	1" Hg	
Vac. Sig. to Open		1" Hg	1" Hg	
Engine Coolant Sensor	8993298	4114-4743 ohms @ 15^{o}C 77.7 - 84.0 ohms @ 128^{o}C	4700 ohms @ 15^{o}C 82.0 ohms @ 128^{o}C	
Thermostat		195^{o}F Fully Open	190^{o} Fully Open	Replaced
Electronic Control Unit	16010154			Replaced

ENGINE CALIBRATION DATA

Vehicle No. 4, 1981 Dodge Aries, BCR22V2HUS

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
Spark Plug Gap		0.035"	0.036 - 0.040"	Reset to spec.
Curb Idle		900 RPM	900 RPM	
Timing		10^{o}BTC	10^{o}BTC	
Fast Idle		1600 RPM	1600 RPM	
Choke Kick		0.035" ± 0.010	0.035"	
Oxygen Sensor	4004675	$\geq$ 600 mv, $\leq$ 200 mv	0-1v	
Bowl Vent Valve	5214336			
Close point		10" H_2O max.	9" H_2O	
Time Delay		10 sec. ± 2.5	8 sec.	
Choke Delayer	4173433	4.0 ± 2 sec.	3 sec.	
Oil Pressure Switch (Engine)		11 psi or less	$>$11 psi	
Gas Cap				Functional Check OK
Engine Temp. Switch	4145716			
Open		$< 137^{o}F$	$135^{o}F$	
Close		$> 113^{o}F$	$115^{o}F$	
Canister Switch	4227009	$<$4.8" Hg	4" Hg	
Carburetor				Functions when energized and increased idle RPM correctly.
Coolant Control Engine Vacuum Switch				
Open		$> 108^{o}F$	$110^{o}F$	
Close		$125 \pm 5^{o}F$	$129^{o}F$	

Vehicle No. 4 (Page Two)

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
EGR Valve				Functional Check OK
Air Pump		$>$ 17#/hr. @ 1000 $\pm$ 10 RPM 1.6 in. Hg	19#/hr. @ 1000 RPM 1.6 in. Hg	
Coolant Control EGR				
Open		98 $\pm$ 5°F	96°F	
Close		$>$ 86°F	87°F	
Combined ASV/Relief Valve				
Relief Pressure		8.2 to 10.5 psi	10.0 psi	
Min. Vacuum to Switch		3.0"Hg max.	3 in. Hg	
Valve Seat Leakage		500 SCCM max. @ 5 psi	Ø SCCM @ 5 psi	
Heated Air Intake Sensor	4100651	75 $\pm$ 5°F @ 3 in. Hg output + 18 in. Hg input	77°F @ 3 in. Hg + 18 in. Hg	
Vacuum Actuated Electrical Switch	5213199	2.5 $\pm$ 1.0 in. Hg	2.75 in. Hg	
Heated Air Delay Valve	4201385	35.0 $\pm$ 7.0 sec.	37.0 sec.	
Vacuum Switch Delay Valve	4C95316	10.0 $\pm$ 2.5 sec.	11.0 sec.	
Thermostat	5214646			
Starts to Open		192 - 199°F	193°F	
Fully open		219°F max.	212°F	
CCV Valve	5214088	0.8 - 1.2 CFM @ 14" Hg 1.2 CFM max. @ 6" Hg 2.4 CFM min. @ 3" Hg	1 CFM @ 14" Hg 1 CFM @ 6" Hg 2.5 CFM @ 3" Hg	

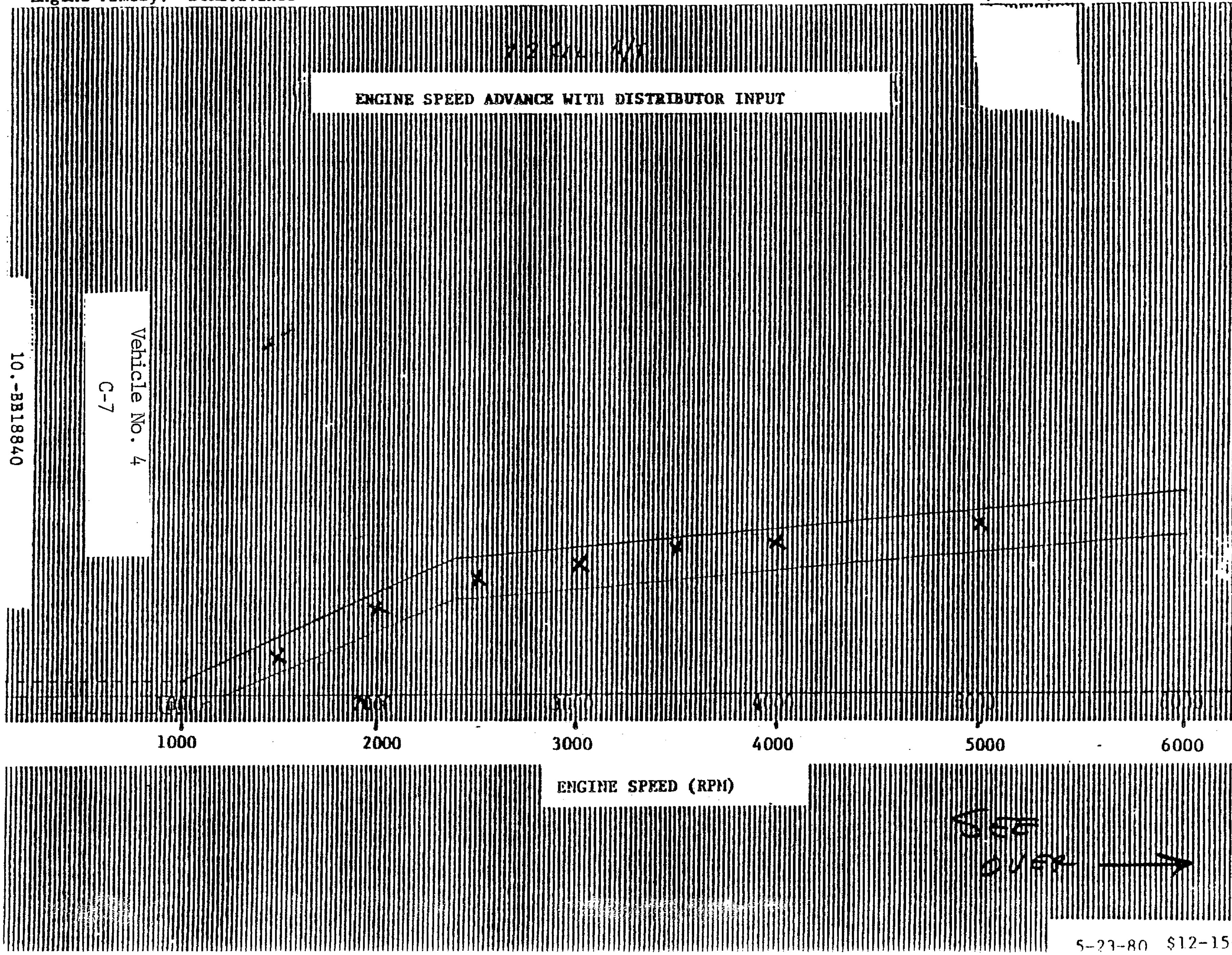
with R.C. #73

$5213345

Engine Family: BCR2.2V2HU8

ESA/EFC P/N: 5213143

1981



Vehicle No. 4

C-7

10.-BB18840

5-23-80 $12-15-80

VEHICLE NO. 4

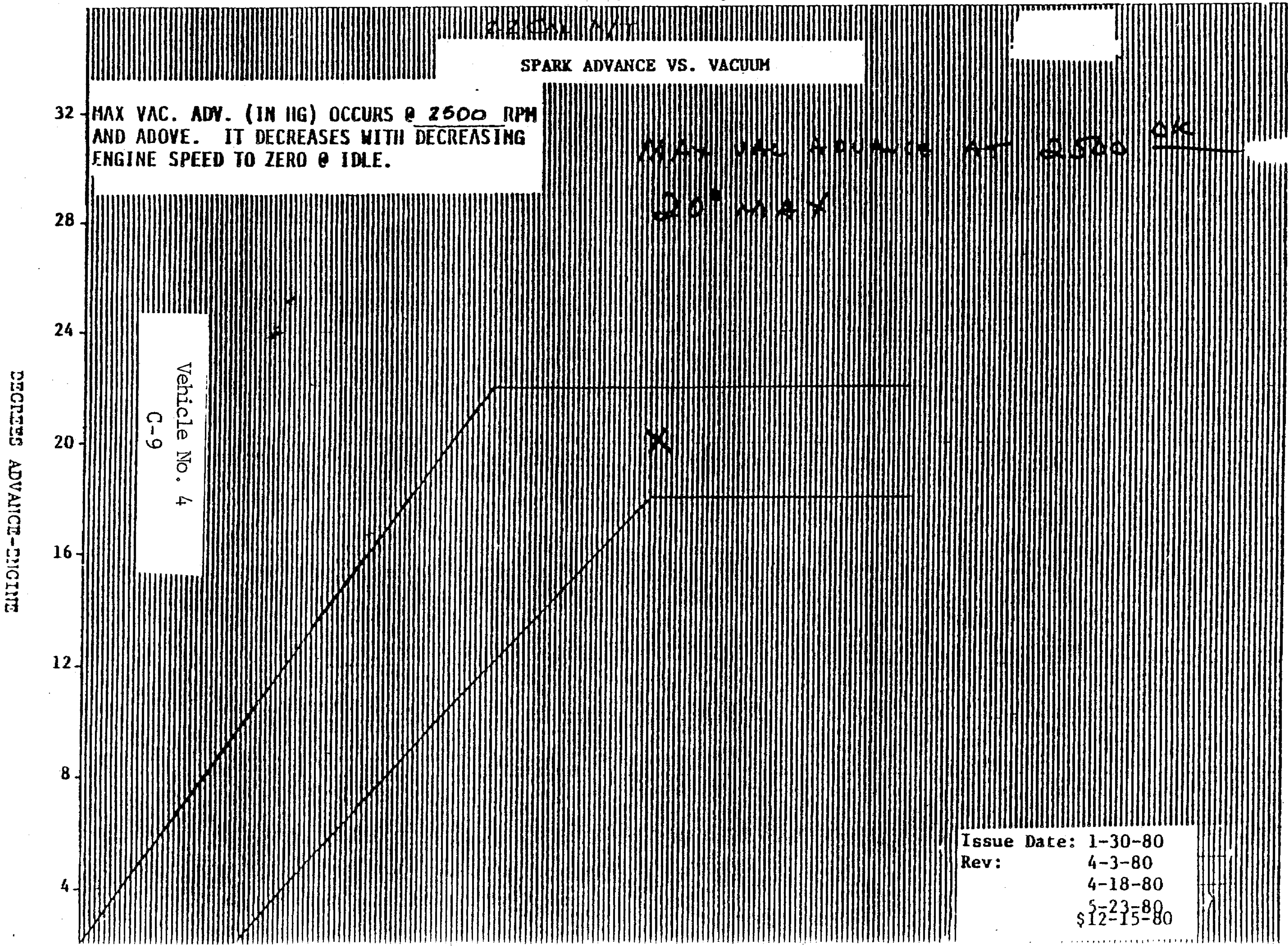
ENGINE RPM

500	-	0°
1000	-	0°
1500	-	3°
2000	-	8°
2500	-	11°
3000	-	12°
3500	-	13°
4000	-	13°
5000	-	16°

KEUFFEL & ESSER CO. MADE IN U.S.A. 46 1510

$ with RC #7

BCR2.2V2HU8 Engine Family ESA/EFC P/N: $5213345 5213143

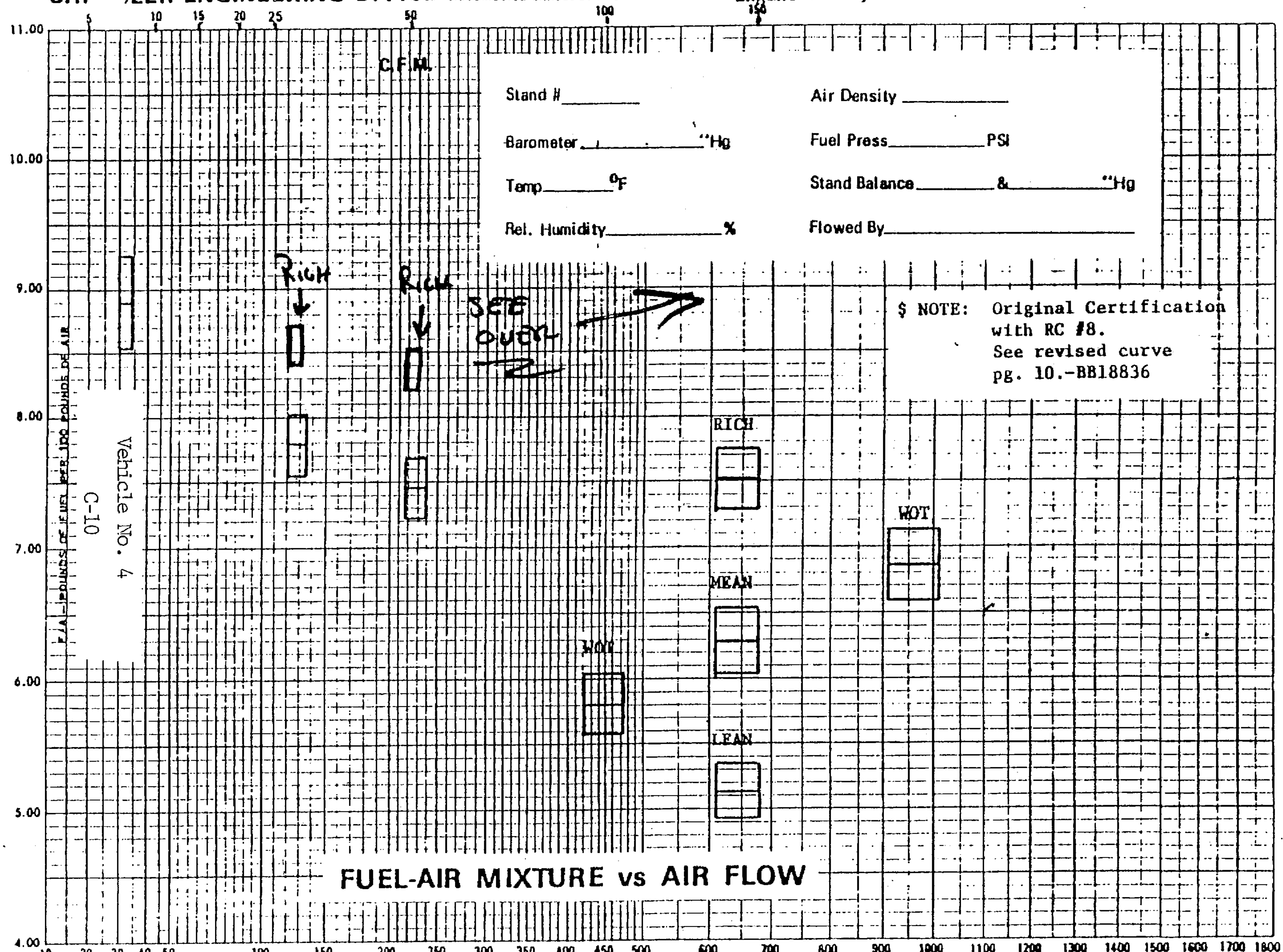


$ w/RC 8,142

CHI LER ENGINEERING OFFICE AUTOMOTIVE CARBURETOR LAL ORY Engine Family: BCR2.2V2HU8

73 (10/74)

1981



4179142 4179163 4179162 ,4179187,4179188

10.-BB18835

VEHICLE NO. 4

Car was quite rich off idle and transition to main circuit.

Visual check confirmed large dribble from main circuit.

Consulted with ARB personnel (Mano), instructed to replace carb and ship them old one.

ENGINE CALIBRATION DATA

Vehicle No. 5   1979 Ford Wagon, 5.8 W "BV" 2TT95x95

Item	Part No.	Spec.	Actual	Remarks
Thermostat		197° $+3°$ $-4°$ F	198° F Replacement	Intermittent operation during testing. Finally frozen open. Replaced.
EEC III Tests*				
Battery Voltage Key on, Eng. off		10.5 Volts	13 Volts	
Reference Voltage Key on, Eng. off		8 to 10 Volts	10 Volts	
Throttle Position Key on, Eng. off		1.8 to 2.8 Volts	1.84 Volts	
Idle		2 ± .3 Volts	1.84 Volts	
50 MPH Cruise		3 to 4 Volts	2.79 Volts	
WOT		8 to 9 Volts	7.2 Volts	
Engine Cooling Temp. Key on, Eng. off		.75 to 2.6 Volts	2.0 Volts	
Mani. Abs. Pressure Key on, Eng. off		7.6 to 8.4 Volts	8.2 Volts	
Idle		2.7 to 3.2 Volts	2.44 Volts	
50 MPH Cruise		3 to 5 Volts	3.7 Volts	
WOT		7 to 9 Volts	7.7 Volts	
Barometric Pressure Key on, Eng. off		7.6 to 8.4 Volts	8.2 Volts	

*On Road

Vehicle No. 5 (Page 2)

EEC III Tests (Cont'd.)

EGR Valve				
Key on, Eng. off		1.4 to 2.45 Volts	1.6 Volts	
Idle		1.4 to 2.45 Volts	1.97 Volts	
50 MPH Cruise		2.5 to 4.5 Volts	1.99 to 3.7 Volts	Varied
WOT		1.4 to 2.4 Volts	.9 Volts	
Timing				
Idle		20°	20.4°	
50 MPH Cruise		25 to 35°	24 to 29°	Varied
WOT		0 to 10°	13.9°	
EGO Light				
50 MPH Cruise		Blinking	Blinking	
WOT		Rich	Blinking	Insufficient load on road testing.
FBCA Stepper Motor Light				
50 MPH Cruise		Blinking	Blinking	
WOT		Off	Off	
EGO				
50 MPH Cruise		.2 to .6 Volts	.09 to .8 Volts	Varied
WOT		.7 to .9 Volts	.9 Volts	
Tune Parameters				
Curb Idle RPM		650/D	650/D	
Fast Idle RPM		1900/N	1900/N	
Basic Timing		100 BTDC @ 650 RPM	10° BTDC	
Spark Plugs	ARF-52	.048 to .052 in.	.050 in.	

ENGINE CALIBRATION DATA

Vehicle No. 6, 1980 Buick Skylark - 02X2NC

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
EGR Vacuum Signal Applied (Ported)	3033397			
Activation Value		$120 \pm 5^{o}F$	$123^{o}F$	
Deactivation Value		$110^{o}F$ min.	$112^{o}F$	
Spark Advance Vacuum	3039246			
Activation Value		$120 \pm 5^{o}F$	$124^{o}F$	
Deactivation Value		$110^{o}F$ min.	$110^{o}F$	
Spark Advance Vacuum and Canister Bowl Vent Cont.	527011			
Activation Value		Sudden dec. in vacuum		Functional Check OK
Deactivation Value		6.4 - 9.6 sec.	9.0 sec.	
Oxygen Sensor	8990298	800 mv min @ 0.9	Not recorded	Functional Check OK
		250 mv max @ 1.1	Not recorded	Functional Check OK
				Ultimately Replaced
Fuel Pump Delivery Pressure	6441375	45-55 kPa	52 kPa	
Idle Speeds				
Curb		700 RPM in drive	700 RPM	
A/C Solenoid Active		975 RPM in drive	975 RPM	
Fast		2600 RPM in park	2200 RPM	Reset to spec.
Carburetor Vac. Break Setting - Front	17059724	19^{o}	19^{o}	
Air Inlet System				
Fully Closed to Cold Air		$30^{o}C$	$30^{o}C$	
Fully Open to Cold Air		$55^{o}C$	$56^{o}C$	
Basic Timing	1110569	10^{o}BTC @ 700 RPM or less	8^{o}BTC @ 700 RPM	Reset to spec.
Spark Plug	R44TSX			

Vehicle NO. 6 (Page Two)

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
Aux. Intake Air	10005152			
Activation Value		Sudden increase in vacuum		Functional Check OK
Deactivation Value		Decrease in vacuum		Functional Check OK
Throttle Position Signal to ECM - Switch "B"	10007036			
Activation Value		5.0 $\pm$ .7" Hg	5.2" Hg	
Deactivation Value		5.5 $\pm$ .7" Hg	5.6" Hg	
Throttle Position Signal to ECM - Switch "A"	10007036			
Activation Value		8.5 $\pm$ .7" Hg	9.0" Hg	
Deactivation Value		9.0 $\pm$ .7" Hg	9.2" Hg	
Spark Advance				
Activation Value		62 $\pm$ 5^{o}F	63^{o}F	
Deactivation Value		52^{o}F min.	54^{o}F	
EGR Valve	17064815			Functional Check OK
Electronic Control Unit	1224330			Replaced

ENGINE CALIBRATION DATA

Vehicle No. 7, 1980 Mazda GLC, OHC4

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
Thermostat		Start to open @ 88 $\pm$ 1.5°C	89°C	
Fuel Pump Delivery Pressure		2.84 - 3.84 psi	3.5 psi	
Engine Idle Mixture - CO concentration		2.5 $\pm$ 1.5%	4.5%	Reset to spec.
Air Inlet Temp Control Sys.		Ambient Air @ 57°C, 73°C	Ambient Air @ 58°C, 72°C	
Initial Timing				
Neutral		5 $\pm$ 1°BTDC @ 700 $\pm$ 5 RPM	5 $\pm$ 1°BTDC @ 700 RPM	
Drive		5 $\pm$ 1° BTDC @ 700 $\pm$ 5 RPM	7°BTDC @ 700 RPM	reset to spec.
Advance Timing		5°BTDC - Idle	5°BTDC	
Retard Timing		1°BTDC - Idle	1°BTDC	
Air Injection Pulley Drive Ratio		1.14:1	Not Recorded	Within spec.
Air Pump Flow		95-145 L/min.	135 L/min.	
Air from Air Cleaner		2.0 $\pm$ 0.3 sec.	2 sec.	
Air Cond. Switch				Functional Check OK
Water Thermo Switch No. 1 Coolant Temp				
ON		50 $\pm$ 2°C	52°C	
OFF		43 - 52°C	51°C	

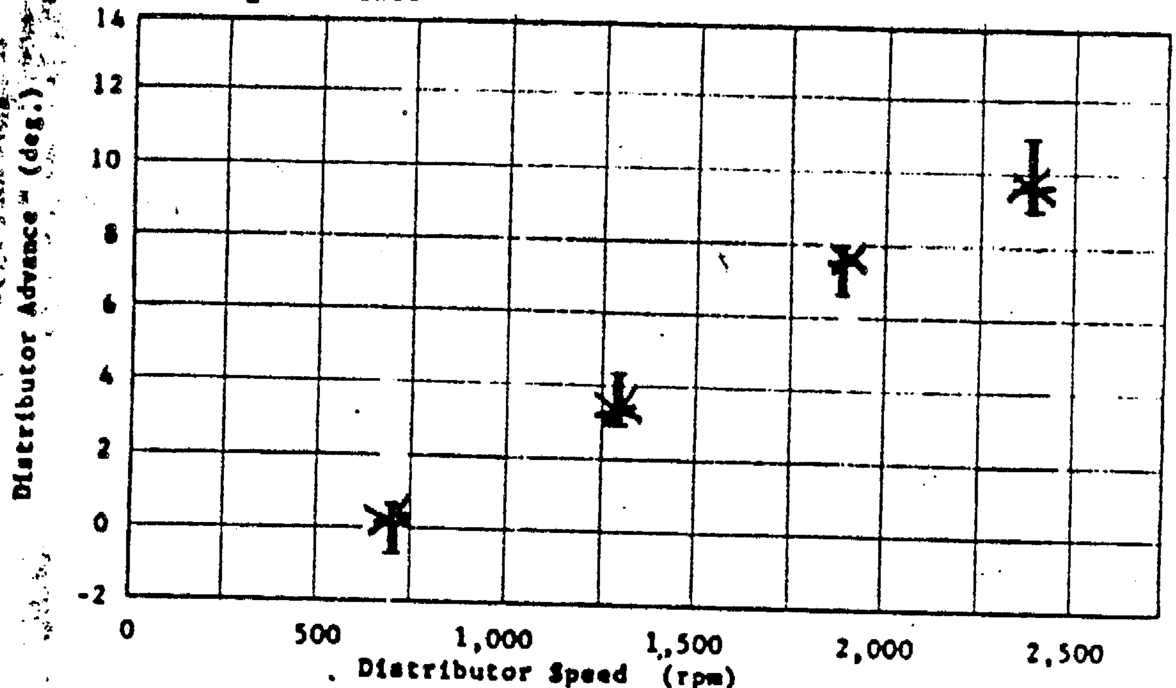
Vehicle No. 7 (Page Two)

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
Water Thermo Switch No. 3 Coolant Temp				
ON		$10 \pm 2^{\circ}C$	$12^{\circ}C$	
OFF		$3 - 12^{\circ}C$	$10^{\circ}C$	
Timer - Time Elapsed from Engine Starting		ON: 120 ± 15 sec.	125 sec.	
Engine Speed - Signal to Solenoid Valve		ON: 1700 ± 100 RPM	1800 RPM	
Vehicle Speed Switch		OFF: 45 ± 2 MPH	47 MPH	
Spark Delay Valve Vacuum Delay Time		15 ± 3 sec.	16 sec.	
EGR Valve				Functional Check OK
Water Thermo Valve No. 2		$<$ 5 cc/min. @ $56^{\circ}C$ $>$ 10 L/min. @ $64^{\circ}C$ $<$ 5 cc/min. @ $50^{\circ}C$	Ø @ $55^{\circ}C$ 12 L/min @ $58^{\circ}C$ Ø @ $47^{\circ}C$	
3-Way Solenoid Valve No. 2				Functional Check OK
3-Way Solenoid Valve No. 1				Functional Check OK
Accelerator Switch				Functional Check OK
Check Valve				Functional Check OK

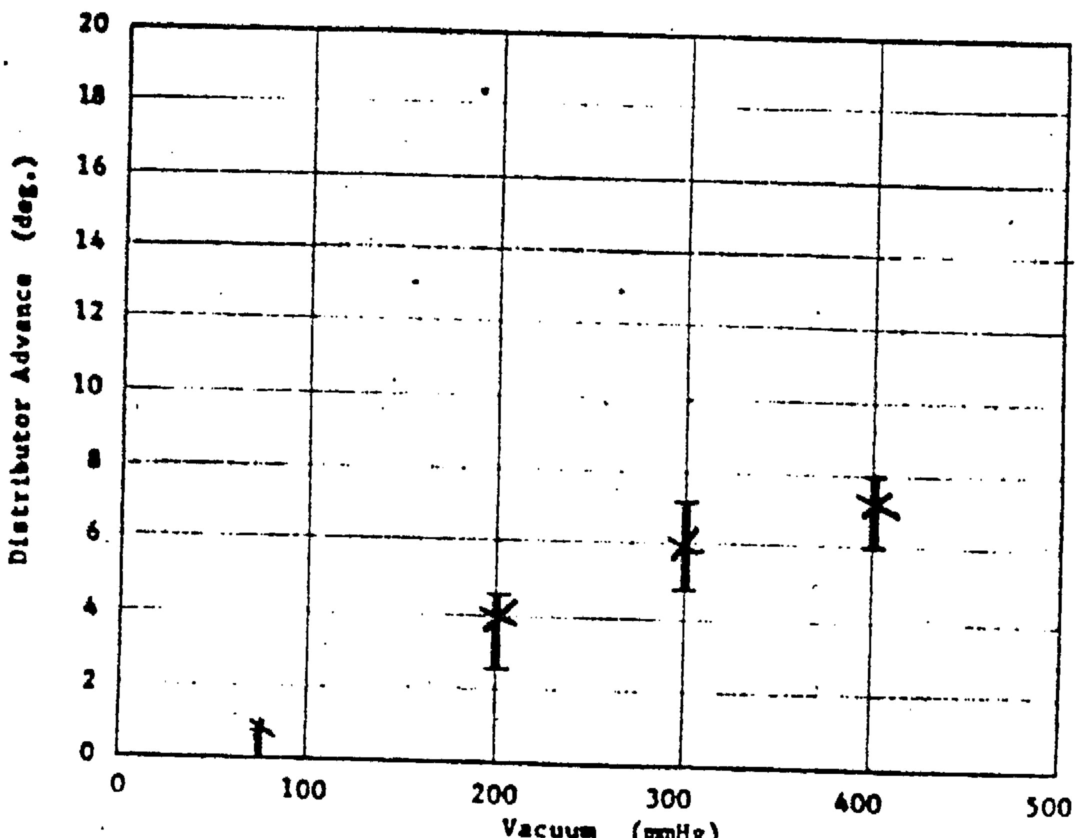
Family Identification: OUCP

Fig.10U-7 DISTRIBUTOR ADVANCE CURVE

(1) Centrifugal Advance



(2) Vacuum Advance



Issue Date: Nov. 24 1979

Rev.

Vehicle No.7

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ENGINE CALIBRATION DATA

Vehicle No. 11   1981 Ford Granada, 2.3AX

Item	Part No.	Spec.	Actual	Remarks
Emissions Sticker	E12E-9C485-HB			
Distributor	E0EE-12127-BA			
Thermostat		192° + 3° F - 4°	201° F	Replacement 193° F
Elec Control System AECDs Air Cleaner Cold		Closed 60-50° F	57° F	
Weather Modulator		Open 76° F	81° F	
Vac Cont. Vlv. 3-Port w/Elec Sw. (N/O)		Open 90-100° F Max. 10 SCCM below 80°F	92° F 0 SCMM below 80°F	
Vac Reg/Solenoid		50% duty output 2.13 to 2.93 in.Hg.	2.4 in.Hg.	
Vac Cont Switch		Close 3.0 ± .5 in.Hg.	3.0 in.Hg.	
Fuel System AECDO Solenoid Vlv (N.C.)				Functional check OK
Carburetor	EIDE-9510-EA			
Switch Assy-Idle Tracking				EEC II test equipment indicates OK
Starting Pulldown Modulator		.051 to .071 in.	.068 in.	
Air Cleaner Duct/ Vlv Vac Motor		Closed below 2 in.Hg. Open above 4 in.Hg.	2.0 in.Hg. 4.6 in.Hg.	
A/Cl Bi-Metal Sensor		Temp 75° F	77° F	

Vehicle No. 11 (Page 2)

A/Cl Cold Weather		Closed 60-50° F	58° F	
Modulator		Open 76° F	76° F	
Crankcase Em Control				
PCV		1.7-2.4 CFM @ 3 in.Hg. 1.9-2.5 CFM @ 8 in.Hg. 1.7-2.1 CFM @ 17 in.Hg.	1.8 @ 3 in.Hg. 2.0 @ 8 in.Hg. 2.0 @ 17 in.Hg.	
Air Injection AECD_				
Thermactor Air Pump				
Min. Backpressure		1.6 in.Hg	1.9 in.Hg.	
Air Flow (min.)		17 lb/hr	22 lb/hr	
Air Control/Bypass Vlv. Pressure		18 to 22 in.Hg.	Avg. 19 in.Hg.	Varies
EGR				
EGR Valve, Integ				
Xducer Backpressure				
Starts to Open		1.8 to 2.2 in.Hg.		Functional Check Ok
Flow Rate		10.5 to 14.3 CFM		
A/Cl Cold Weather		Closed below 40° F	40° F	
Modulator		Open above 55° F	58° F	
Vac Cont Vlv 3-Port		Open 90-100° F	97° F	
w/Elec Sw (N.O.)		Max 10 SCCM below 80° F	OSCCM below 79° F	
Tune Parameters				
Curb Idle RPM		750/D	750	
Fast Idle RPM		High Cam/N	2400	
Kickdown RPM		2300/N	1500	
Basic Timing		12° BTDC @ 700 RPM	12° BTDC	
Spark Plugs	AWSF-42	.032-.036 in.	.037 to .040	Regapped to .035

ENGINE CALIBRATION DATA

Vehicle No. 12   1980 VW Jetta, 37CL

Item	Part No.	Spec.	Actual	Remarks
Air System			No Leaks	
Engine "Warm" Control Pressure		3.40-3.80 bar	3.80 bar	
System Pressure		4.50-5.20 bar	5.10 bar	
Fuel Pump Check Valve		>1.8 bar	>1.8 bar	
Fuel Pump Delivery Rate		>900 ml/30sec.	908 ml/30sec.	
Fuel Pump Current Draw		<8.5 amperes	7 amperes	
Mixture Control Unit-Sensor Plate		Uniform Resistance		Functional Check OK
Control Pressure Regulator		2.00-2.60 bar	2.6 bar	
Control Pressure Regulator Plug		>11.5 volts	13 volts	
Heating Element		16-22 ohms	22 ohms	
Thermo-Time Switch				Functional Check OK
Cold Start Valve				Functional Check OK
Auxiliary Air Regulator Valve				Functional Check OK

Vehicle No. 12 (Page 2)

Auxiliary Air Regulator Resistance	30 ohms	30 ohms	
Air Cleaner Warm Air Opening	Seals at 93-97° F	97° F	
Throttle Valve Port	0.2-0.3 in.Hg	0.1 in.Hg.	Valve Port Cleaned
Vacuum Amplifier	2-4 in.Hg.	4 in.Hg.	
Decel Valve			Functional Check OK
Thermostat	Water > 93° F	97° F	
PCV			Functional Check OK
Thermo Switch	Ø ohms < 68° F inf. ohms > 77° F	Ø ohms < 68° F inf. ohms > 77° F	
Frequency Valve	2-3 ohms	3 ohms	
Fuel Injectors Opening Pressure	3.2-3.8 bar	3.8 bar	
Cooling Fan Switch	190-199° F	195° F	
Cooling Water Thermostat	185-192° F	188° F	
Cold Air Intake Closed	68° ± 2° F	65° F	
Open @ 503 mm Hg.	84° ± 2° F	82° F	

Vehicle No. 12 (Page 3)

Manifold Vacuum		
Closed	70 ± 6° F	75° F
Open	80 ± 8° F	87° F
Solenoid Starting Valve	115 ± 15cm ^{3}/min.	125cm ^{3}/min.

OK. in spec

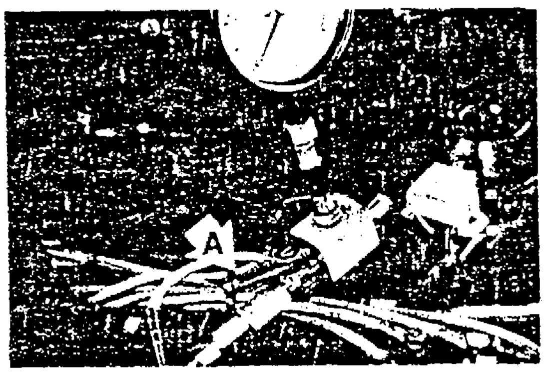
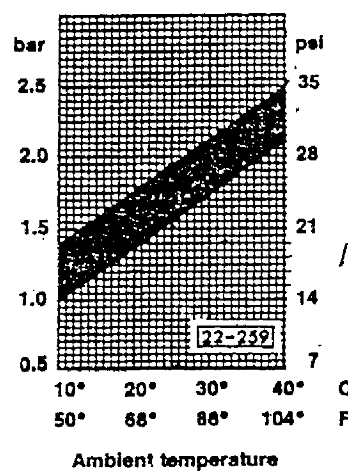


Fig. 7-9. Pressure gauge correctly installed. Operating lever of three-way valve is at position **A**.

2. Connect the hose you disconnected from the fuel distributor to the inlet hose of the pressure gauge's three-way valve.
3. Disconnect the electrical plugs from the control pressure regulator and from the auxiliary air regula-

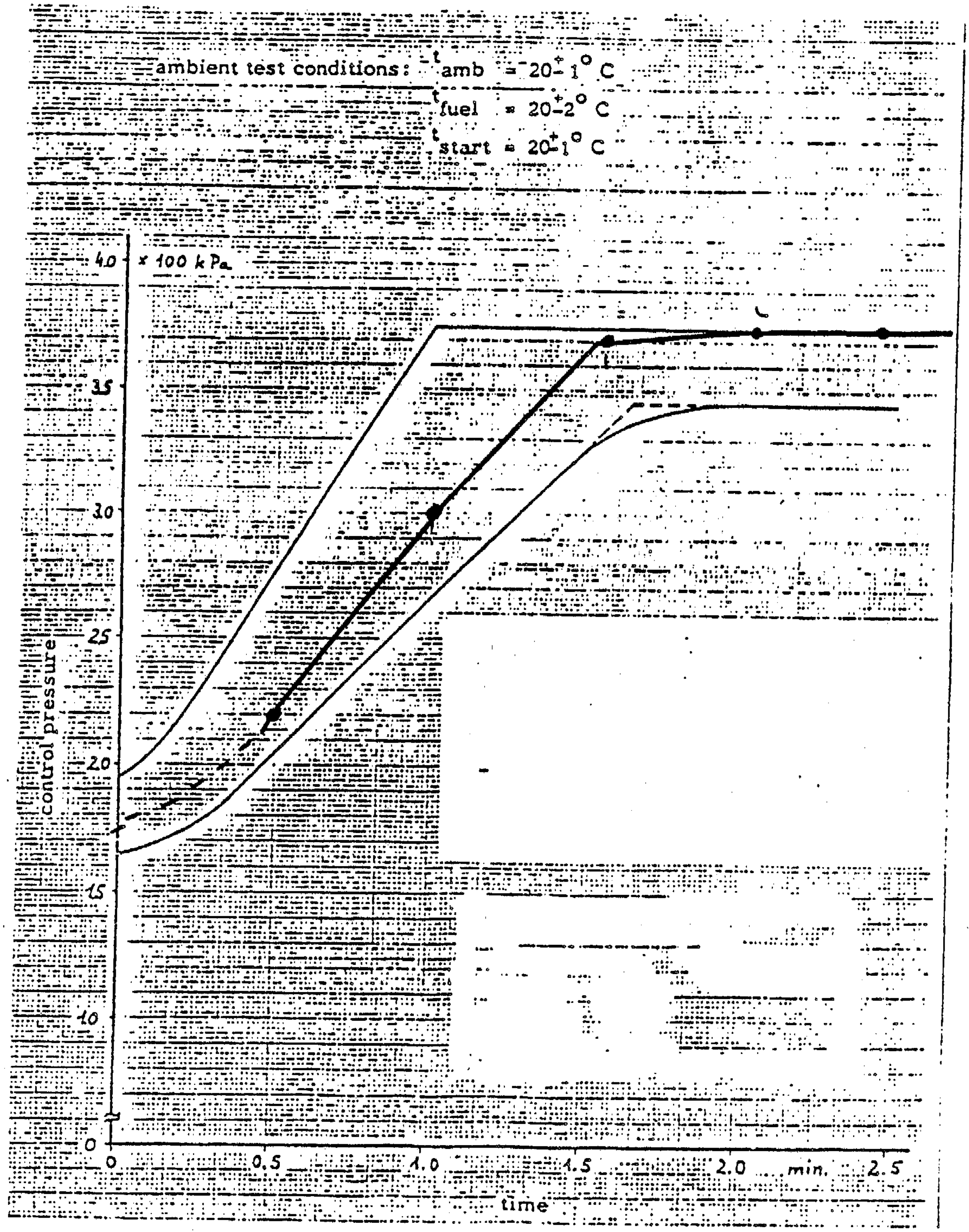


68°F – 1.4 BAR
75°F – 1.5 BAR
80°F – 1.6 BAR
86°F – 1.7 BAR
95°F – 2.0 BAR
104°F – 2.3 BAR

Fig. 7-10. Graph of acceptable "Engine cold" control pressures. For example, at 30°C (86°F), the "Engine cold" control pressure should be between 1.70 and 2.10 bar.

VEHICLE NO. 12

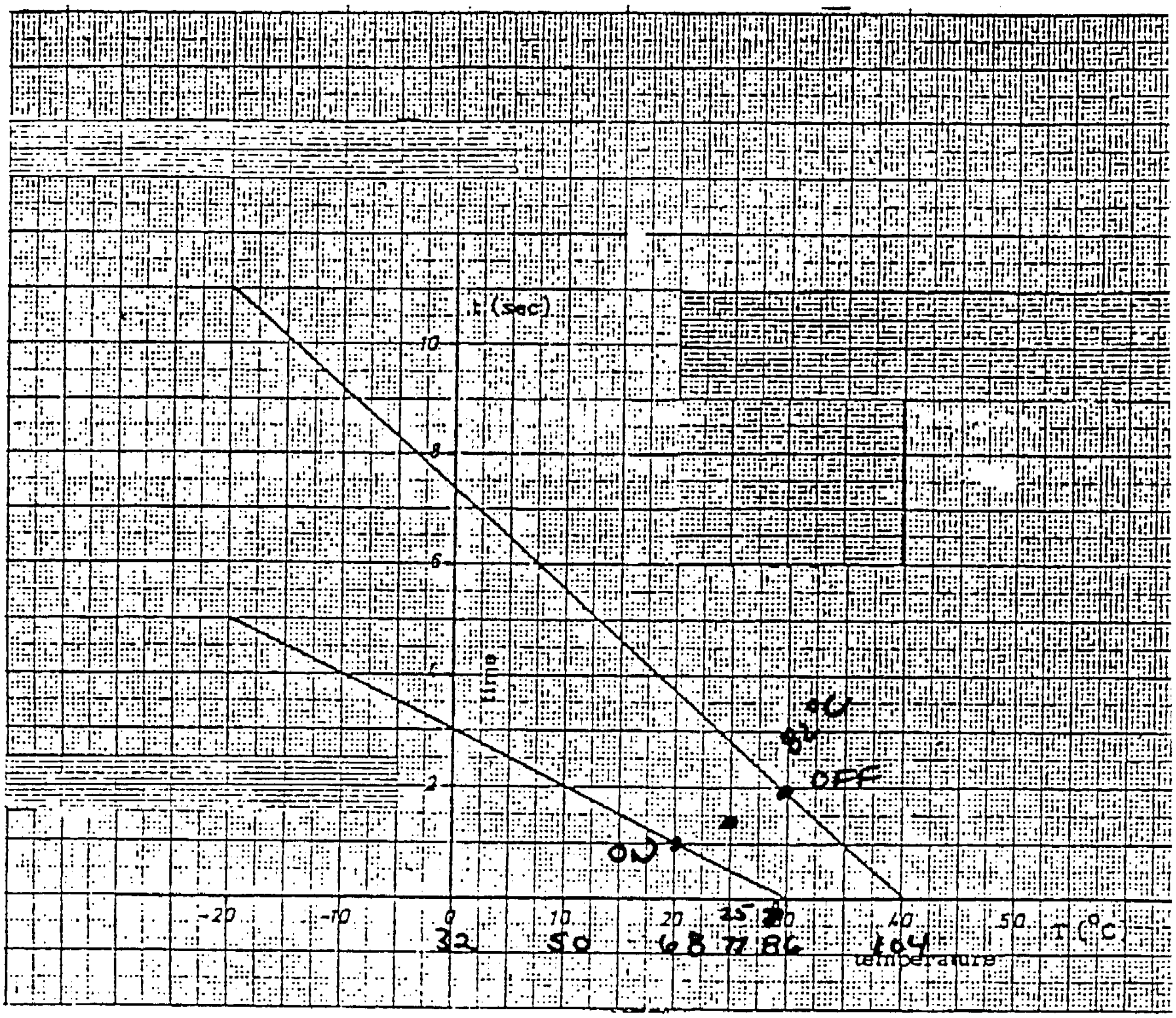
Calibration Curve for Warm-up Unit



Issue Date: NOV 15 1978	Vehicle No. 12			
Revision Date:				
Page is satisfactory ☐ yes ☐ no	Date:	EPA Rep.		

	engine family: 37 CL	page no.: 08.01. -25
	engine code: all	section no.: 08.01.02.02

Calibration Curve for Thermo Time Switch

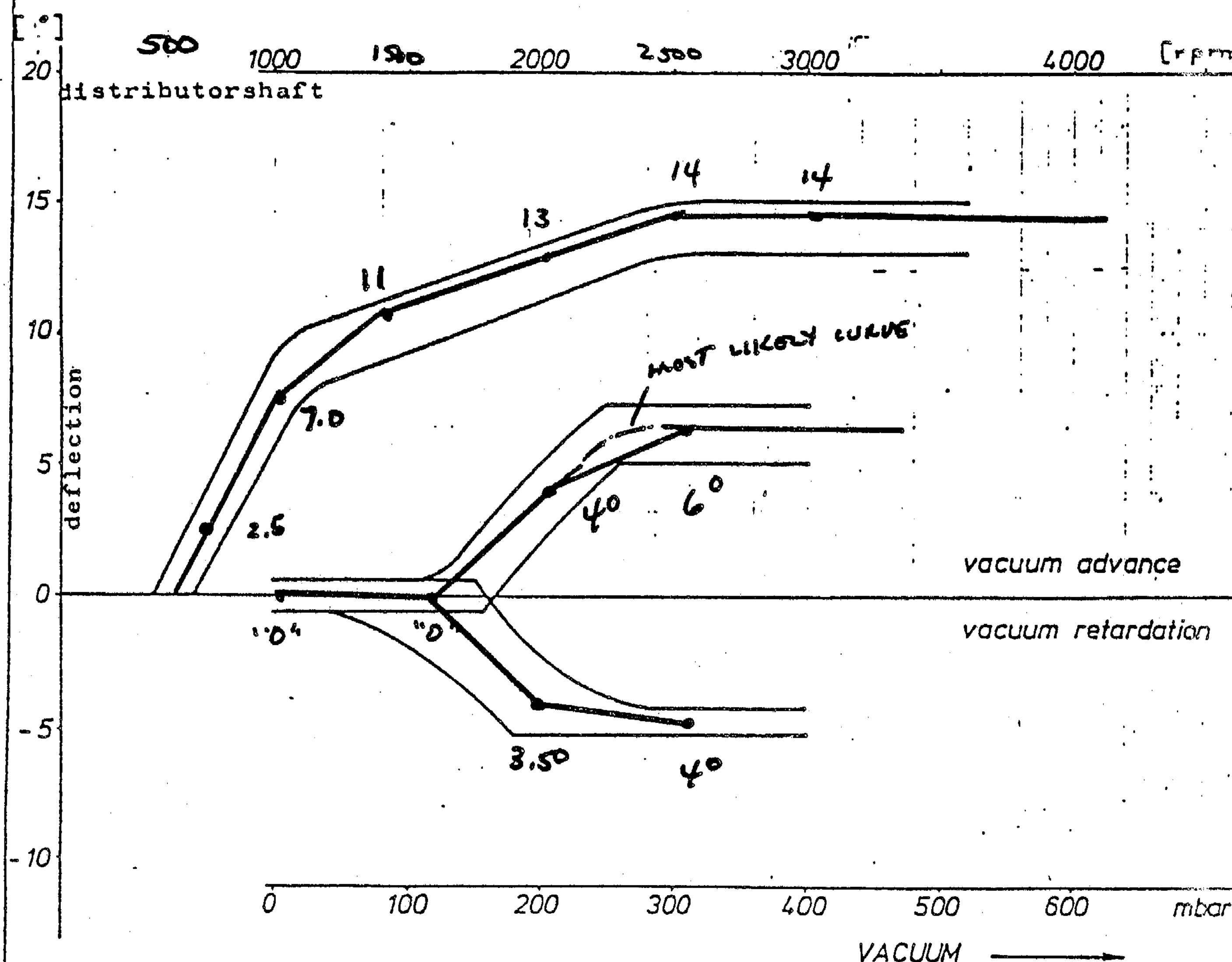


Issue Date: NOV 15 1978	Vehicle No. 12		
Revision Date:			
Page is satisfactory ☐ yes ☐ no	Date:	EPA Rep.	

	engine family: 37 CL	page no.: 08.02. -07
	engine code: all	section no.: 08.02.01.00

Distributor Advance Curve

b) Transistorized Ignition System



Issue Date: NOV 15 1978	Vehicle No. 12			
Revision Date:				
Page is satisfactory ☐ yes ☐ no	Date:	EPA Rep.		

Vehicle No. 13 1980 Chevrolet Caprice

ENGINE CALIBRATION DATA

Item	Part No.	Spec.	Actual	Remarks
Oxygen Sensor	8990298	800 mv min @ 0.9 250 mv max @ 1.1		Shows correct dwell output from ECU indicating switching.
Fuel Pump	6440987	7.5 - 9.0 psi	8.2 psi	
Automatic Choke	17064473	130±26 sec @ 75°F	150 sec @72°F	No apparent tampering.
Air Inlet				
Fully Closed		Below 85°F	OK	
Fully Open		Above 130°F	132°F	
Vac Motor Travel		2-6 in. Hg		Functional check ok.
Spark Plugs		AC-R45TS	Same	
Wax Pellet Switch				
(EGR, Canister Purge)	3036912			
Activation Value		130±3°F	131°F	
Deactivation Value		120°F min	125°F	
Wax Pellet Switch				
(EFE)	3043015			
Activation Value		90±3°F	90°F	
Deactivation Value		80°F min.	85°F	
Vacuum Check Valve				
(EFE)	460734			Functional check ok.
Wax Pellet Switch				
(Distributor)	3031385			
Activation Value		120±3°F	122°F	
Deactivation Value		110°F min.	113°F	

Item	Part No.	Spec.	Actual	Remarks
Wax Pellet Switch				
(Dist. TV & CARB Sec Vac Break)	3043541			
Activation Value		62±3°F	64°F	
Deactivation Value		50°F min.	52°F	
Dist. Vac Delay Valve	14015578			Functional check ok.
Elec AIR Control Valve	17058244			Functional check ok.
AIR Check Valves(2)	22016902			Functional check on car ok.
EFE				
Vac Sig to Close	5233650	7 in Hg min.	7.3 in Hg	
Vac Sig to Open		1 in Hg max.	1.0 in Hg	
PCV Valve	8997988			Functional check ok.
EGR Valve	17064539			Functional check ok.
Tune Parameter				
Curb Idle		550/D	550/D	
AC Sol Act Idle		650/D	650/D	
Fast Idle		2200/N	1500/N	Adj. to 2200/N
Basic Timing		4°BTDC @ 550 RPM	0°BTDC	Reset to 4°BTDC
Other Components				
ECM	16006131			
Carburetor	17080504			
Distributor	1103386			
Air Pump	7832872			

Vehicle No. 14 1980 Ford Mustang, 4V

Item	Part No.	Spec.	Actual	Remarks
Calibration No.: 0-02T-R10A/N				
Distributor No.: EOEE-12127-DA				
Carburetor No.: EOEE-NC				
Thermostat	D9FZ-8575-A	192° F (+3, -4)	180° F	Replaced, 190°F
Fuel Pump Pressure		5.0-6.5 psi 1000 cam RPM	4.8 psi @ 2000 RPM crank	
Plug Gap	AWRF-42	.032-.036 in.	.043 in. Atlas 445R	Reset to .035 in.
Tune Parameter				
Fast Idle		2000/N	2000/N	
Curb Idle		850/N	830/N	
Basic Timing		6° BTDC @ 650 RPM	5.5° BTDC @ 650 RPM	
Vacuum Control Switch		>1.5 ± .5 in.Hg.	1.5 in.Hg.	
Exhaust Gas Oxygen Sensor		0-1 volt	0.23-0.80 volt	Switching
Vac Regulator Solenoid				
Input Vacuum		>5" Hg.		Controlled by ECU
Output Vacuum		0-5.82" Hg.		
50% Duty Output		2.13-2.93" Hg.	2.5 in. Hg.	
Vacuum Control Valve - 4-Port				
Bottom Ports Flow		90-100° F	94° F	
Top Ports Flow		By 105° F	106° F	
No Flow Above		10 SCCM Below 80° F	Ø SCCM Below 80° F	
Solenoid Valve				Functional Check OK

Vehicle No. 14 (Page 2)

Item	Part No.	Spec.	Actual	Remarks
Vac Retard Delay Valve		200 ± 40 sec.	600 sec.	
Vac Operated Throttle Modulator		Not Adjustable		
Pulldown Modulator		0.051-0.071 in.	0.069	
Air Cleaner Duct and Valve Vacuum Motor				
Open		>5 in.Hg.	5 in.Hg.	
Closed		<1 in.Hg.	1.5 in.Hg.	
Air Cleaner Bi-Metal Sensor				
Temp.		75° F	75° F	
Output Vacuum		1-5 in.Hg.	Variable max 5 in.Hg.	
Air Cleaner Cold Weather Modulator				
Closed		50-60° F	50° F	Green
Open		>76° F	76° F	
PCV Valve Flow Rates		1.5-2.5 CFM @ 3" Hg.	1.75 CFM @ 3" Hg.	
		1.5-2.5 CFM @ 6" Hg.	1.75 CFM @ 6" Hg.	
		.75-1.25 CFM @ 15" Hg.	1.0 CFM @ 15" Hg.	
Thermactor Air Pump				
Min. Backpressure		1.3 in.Hg.	1.25 in.Hg.	
Air Flow		31 lb/hr.	35 lb/hr.	
Thermactor Air Bypass Valve				
Vacuum Signal		0 in.Hg.	0 in.Hg.	
Outlet Pressure		20.7 + 1.5 in.Hg.	21 in.Hg.	

Vehicle No. 14 (Page 3)

Item	Part No.	Spec.	Actual	Remarks
Air Control Valve				
Outlet Air @ A		0.5 max.,	0.0	
		9.5 min. CFM	9.0	
Outlet Air @ B		9.5 min.,	9.0	
		0.5 max. CFM	0.0	
Air Cleaner Temp. Vacuum Switch				
Open		<50° F	40° F	Red
Close		>65° F	68° F	
Vac Control Valve				
Starts to Open		90-100° F	90° F	
No Flow Above		10 SCCM Below 80° F	0 SCCM Below 80° F	
Vacuum Retard Delay Valve		10 ± 2 sec.	8 sec.	
Anti-Backfire Valve		1.0 - 2.9 sec.	2.5 sec.	
Vac Regulator Valve				
Output Vacuum		6 ± .5 in.Hg.	6 in.Hg.	
EGR Valve-Tapered Stem Type				
Starts to Open		2.8 - 3.2 in.Hg.	3.5 in.Hg.	
Flow Rate		5.0 - 6.4 CFM	6.2 CFM	
Air Cleaner Cold Weather Modulator				
Closed		<40° F	40° F	Blue
Open		>55° F	63° F	
Vac. Control Valve - 4-Port				
Bottom Ports Flow		90-100° F	94° F	
Top Ports Flow		By 105° F	106° F	
No Flow Above		10 SCCM Below 80° F	0 SCCM Below 80° F	

Vehicle No. 14 (Page 4)

Item	Part No.	Spec.	Actual	Remarks
Solenoid Valve (N.O.)		Activated When Energized	Activated When Energized	Functional Check OK
Solenoid Valve (N.C.)		Activated When Energized	Activated When Energized	Functional Check OK

CARB Vehicle No. 14 - 1980 Ford Mustang

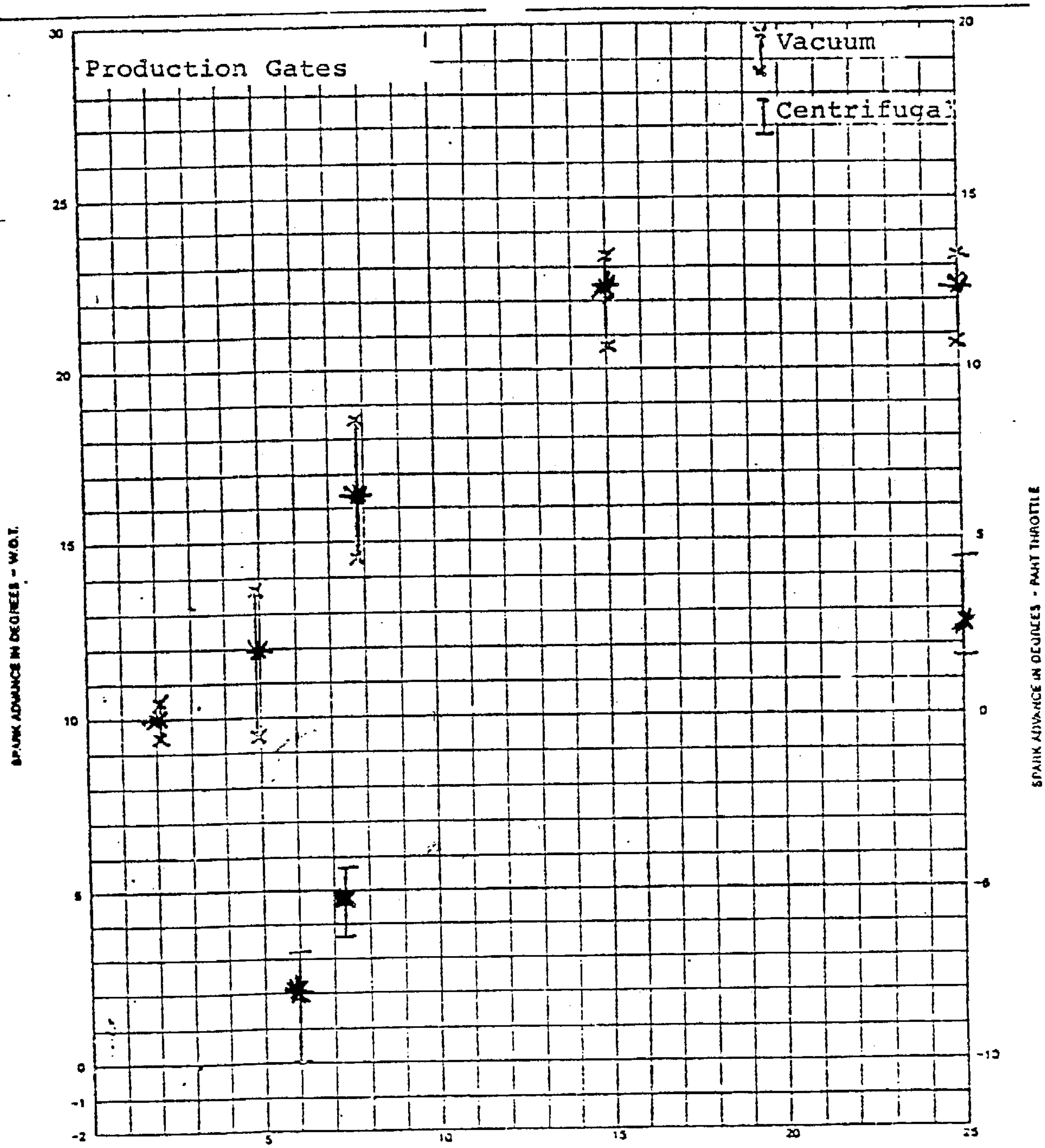
DISTRIBUTOR PERFORMANCE CURVE

CALIBRATION SPECIFICATION
FORD MOTOR COMPANY

DISTRIBUTOR MAKE FORD

APPLICATION 1980 2.3L

PART NO. E0EE-12127-DA



PAGE OF PAGES

Engine Family: 2.3 AX

Issue Date:		10C-2	Page is ☐ Satisfactory ☐ Unsatisfactory Date __/__/__ EPA Rep ____
Revised:	MAY 25 '79		

Vehicle No. 15, 1981 Datsun GX 310, BNS1.5V2AC7

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
Crankcase Emission Control Valve Air Flow				
150 mm Hg		22-34 L/min.	27 L/min.	
500 mm Hg		9-15 L/min.	12 L/min.	
Engine Idle Speed		750 RPM in neutral	650 RPM in neutral	Reset to spec.
Initial Timing		5^{o}BTDC @ 750 RPM in drive	3.2^{o}BTDC @ 650 RPM in drive	Reset to spec.
Vacuum Delay Valve (Type C) Catalyst Warm Up Bleed Down Time		20± 4 sec.	4.1 sec. @ 20 in. Hg	Error in test procedure due to spec not consistent with other mfg.
Anti-Backfire Valve		0.40 - 0.80 sec. @ 500 mm Hg	1 sec. @ 482 mm Hg	
Speed Detecting Switch				
42 - 47 MPH		Off to On	On to Off	Switches appear to be opposite; however, solenoid functions correctly.
40 - 45 rpm		On to Off	Off to On	
Clutch Switch				
Engaged		On	On	
Disengaged		Off	Off	
Neutral Switch				
Neutral		On	On	
Others		Off	Off	
Vacuum Switching Valve (Type B)	14955-M6710	On	Off	Replaced
Vacuum Switching Valve (Type A)		On	On	

Vehicle No. 15 (Continued)

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
Water Temperature Switch (Type A2)		Off @ 14-20°C	18°C	
Water Temperature Switch (Type A1) Rich-lean & Cat. Warm-up		Off @ 32-38°C	Off @ 33°C	
Thermal Vacuum Valve (Type A) EGR Control Vacuum & Canister Purge Control Vacuum		Open below 55°C Close @ 57-63°C	Close @ 83°C	Replaced
Spark Advance Control Vacuum		Open @ 7-13°C Close @ 57-63°C	Open @12°C Close @ 60°C	
Vacuum Delay Valve EGR (Type B) Bleed Down Time		10 ± 2 sec.	1.4 sec. @ 10 in Hg	Error in test procedure due to spec not consistent with other mfg.
Vacuum Delay Valve Spark Timing Control (Type A) Bleed Down Time		20 ± 4 sec.	4.3 sec. @ 20 in Hg	Error in test procedure due to spec not consistent with other mfg.
Spark Plug Vendor & Identification No.	NGK BP5ES-11	1.0-1.1 mm	.046 in	Rest to .041 in = 1.09 mm
Manifold Vacuum Switch Above operating vehicle		OFF (NC) ON (NO)	Fuel Shut-off system operated	Functional Check OK
Below operating vacuum		ON (NC) OFF (NO)	Fuel Shut-Off system not operated	Functional Check OK

Vehicle No. 15 (Continued)

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
Air Inlet Control System				
Vacuum Motor				
Begin to lift		40-60 mm Hg	50 mm Hg	
Fully lift		80-120 mm Hg	100 mm Hg	
Air Bleed Valve Boost 2		60-95 mm Hg	75 mm Hg	
Fuel Pump Delivery Pressure		0.27 kg/cm^2	0.28 kg/cm^2	
Throttle Opener Operating Vacuum		130 ± 20 mm Hg	120 mm Hg	
Thermostat Calibration				
Begins to open		176.9-182.3°F	186°F	
Fully Open		203°F	200°F	

CARB Vehicle No. 15 - Datsun 310GX

APPENDIX-DIST 1

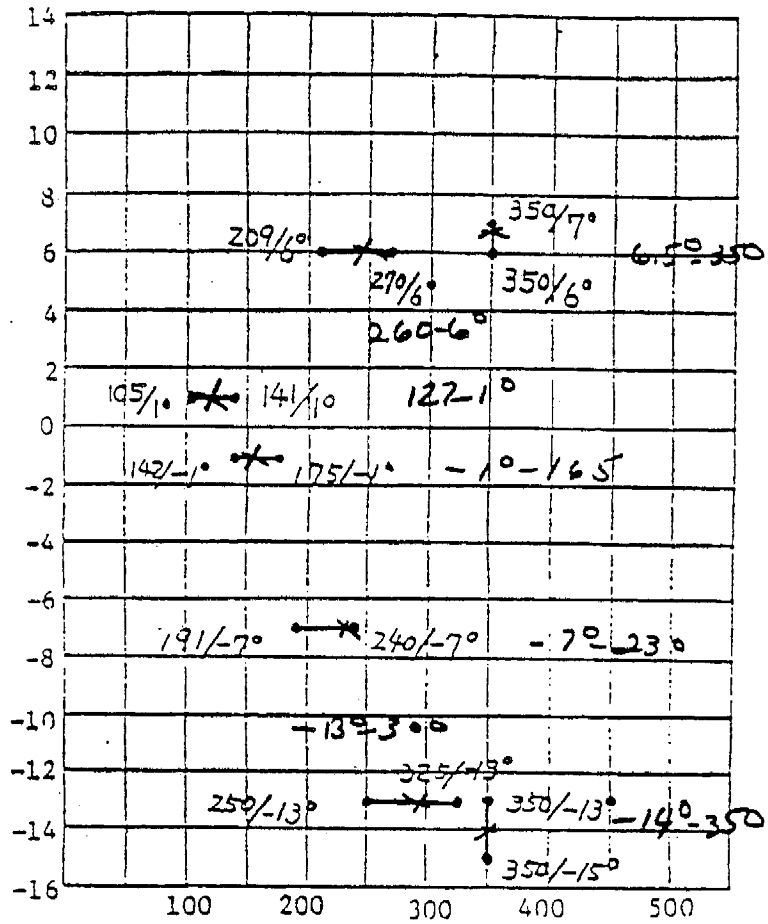
NISSAN

Eng. Family: BNS1.5V2AC7

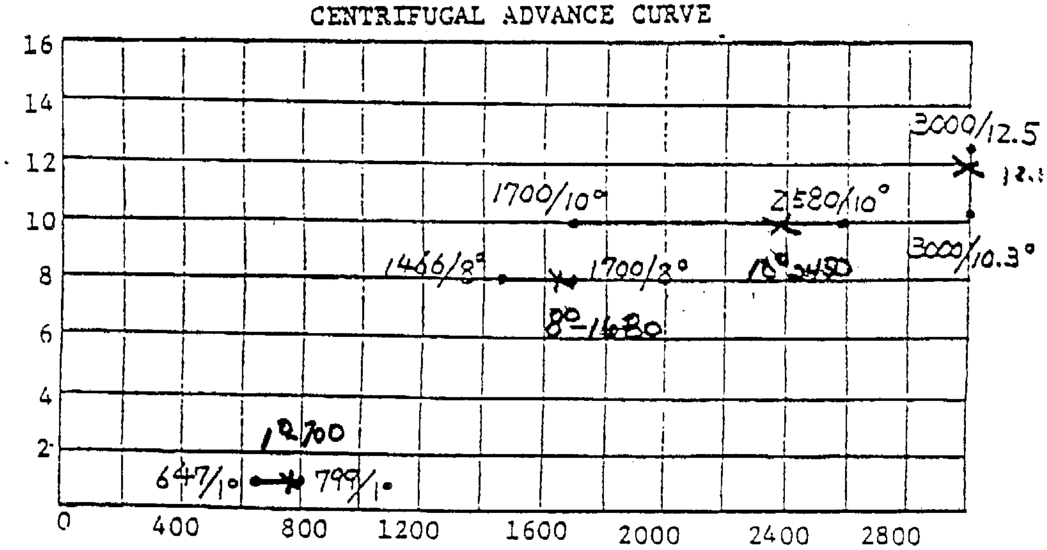
10.04.01.03 Distributor spark advance

Engine Code : BA15CM, ABA15CM / NA15CM, ANA15CM

VACUUM ADVANCE CURVE



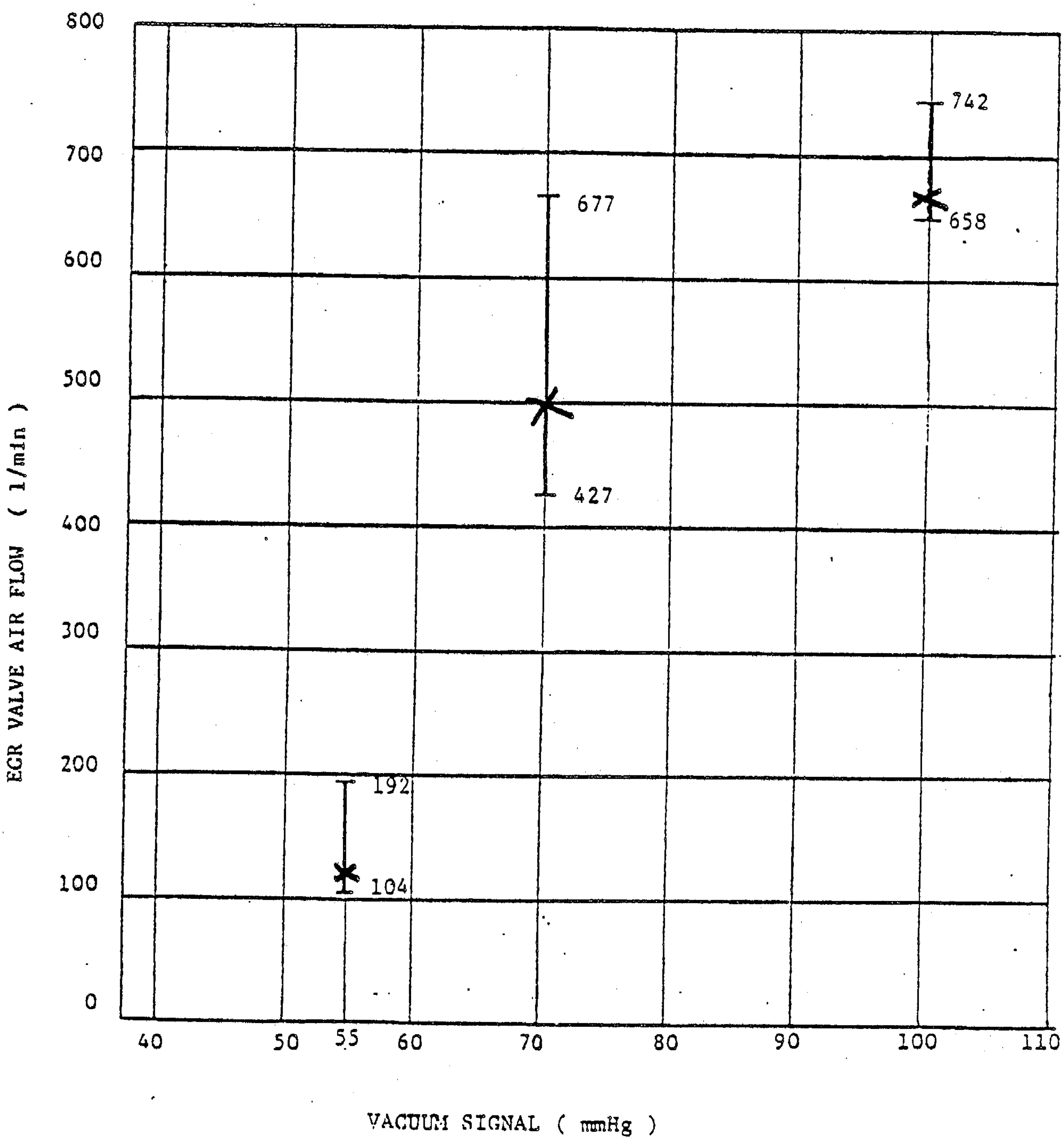
CENTRIFUGAL ADVANCE CURVE



Issue Date: 03/07/80	10- BNS1.5V2AC7 -ADX-17			PAGE IS ☐ SATISFACTORY ☐ UNSATISFACTORY
Revision				DATE __/__/__
Date				EPA REP

C

10.07.03.09 EGR Valve Flow Calibration ok ✓



Issue Date: 03/07/80	10- BNS1.5V2AC7 -ADX-25				PAGE IS ☐ SATISFACTORY ☐ UNSATISFACTORY
Revision					DATE __/__/__
Date					EPA REP

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Vehicle No. 16, 1980 Mercury Cougar XR7, 4.2/5.0 BTC

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
Calibration	0-11N-R10A&N			
Distributor	EOSE-12127-CA			
Carburetor	E04E-9510-VA			
Spark Plug Gap	ASF-52	0.048-0.052"	0.050"	
Ignition Timing		6^{O}BTDC in neutral @ 500 RPM	3^{O}BTDC in neutral @ 500 RPM	reset to specs
Fast Idle - High Cam		2100 RPM in neutral	1850 RPM in neutral	
Curb Idle				
A/C Off		500 in drive	500 in drive	
A/C On		650 in drive	650 in drive	
Crankcase Emission Control System Flow Rates				
3" Hg		4.10-5.10 CFM	5 CFM	
8" Hg		2.60-3.60 CFM	3.5 CFM	
15" Hg		1.30-1.80 CFM	1.5 CFM	
Air Cleaner Temp. Vac. Switch				
Open		$>76^{O}F$	$82^{O}F$	
Closed		$<50^{O}F$	$50^{O}F$	
EGR Valve, Integral Transducer Backpressure				
Transducer Set Point		4.0" Hg	4" Hg	
Flow Rate		12.4-16 CFM	15 CFM	
Vacuum Cont. Valve (4-Port)				
Bot. Ports Flow		$90-100^{O}F$	$98^{O}F$	
Top Ports Flow		By $105^{O}F$	$100^{O}F$	
No Flow Above		105 ccm below $80^{O}F$	$90^{O}F$, 0 SCCM	

Vehicle No. 16 (Page Two)

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
Vacuum Delay Valve (2 way)		3.5 ± .75 sec.	3.5 sec.	
Vacuum Regulator Valve Output Vacuum		8.0 ± .5" Hg	4.5" Hg	Replaced
Vac. Cont. Valve (3 Port)				
Starts to Open		220-230^{o}F	218-230^{o}F	
No Flow Above		10 SCCM below 200^{o}F	200^{o}F, Ø SCCM	
Thermacter Air Pump				
Min. Backpressure		1.3" Hg	1.3" Hg	
Min. Air Flow		31 lbs./hr.	35 lbs./hr.	
Pulley Ratio		1.35:1	1.36:1	
Vac. Retard Delay Valve		375 ± 75 sec.	390 sec.	
Vacuum Delay Valve		20 ± 4 sec.	20 sec.	
Vacuum Cont. Valve (2 port)				
Starts to Flow		123-133^{o}F	132^{o}F	
No Flow Above		10 SCCM below 103^{o}F	Ø SCCM below 102^{o}F	
Dashpot, Throttle Solenoid Positioner Assy.		1.0-2.0 sec. to close	2 sec. to close	
Air Cleaner Duct and Valve Vacuum Motor				
Heat on		$>$9" Hg	9" Hg	
Heat Off		$<$4" Hg	4" Hg	
Air Cleaner Bi-Metal Sensor Output Vacuum		4-9" Hg	4-9" Hg	Varies depending on input
Air Cleaner Cold Weather Modulator				
Closed		$<$40^{o}F	45^{o}F	
Open		$>$55^{o}F	52^{o}F	

DISTRIBUTOR PERFORMANCE CURVE

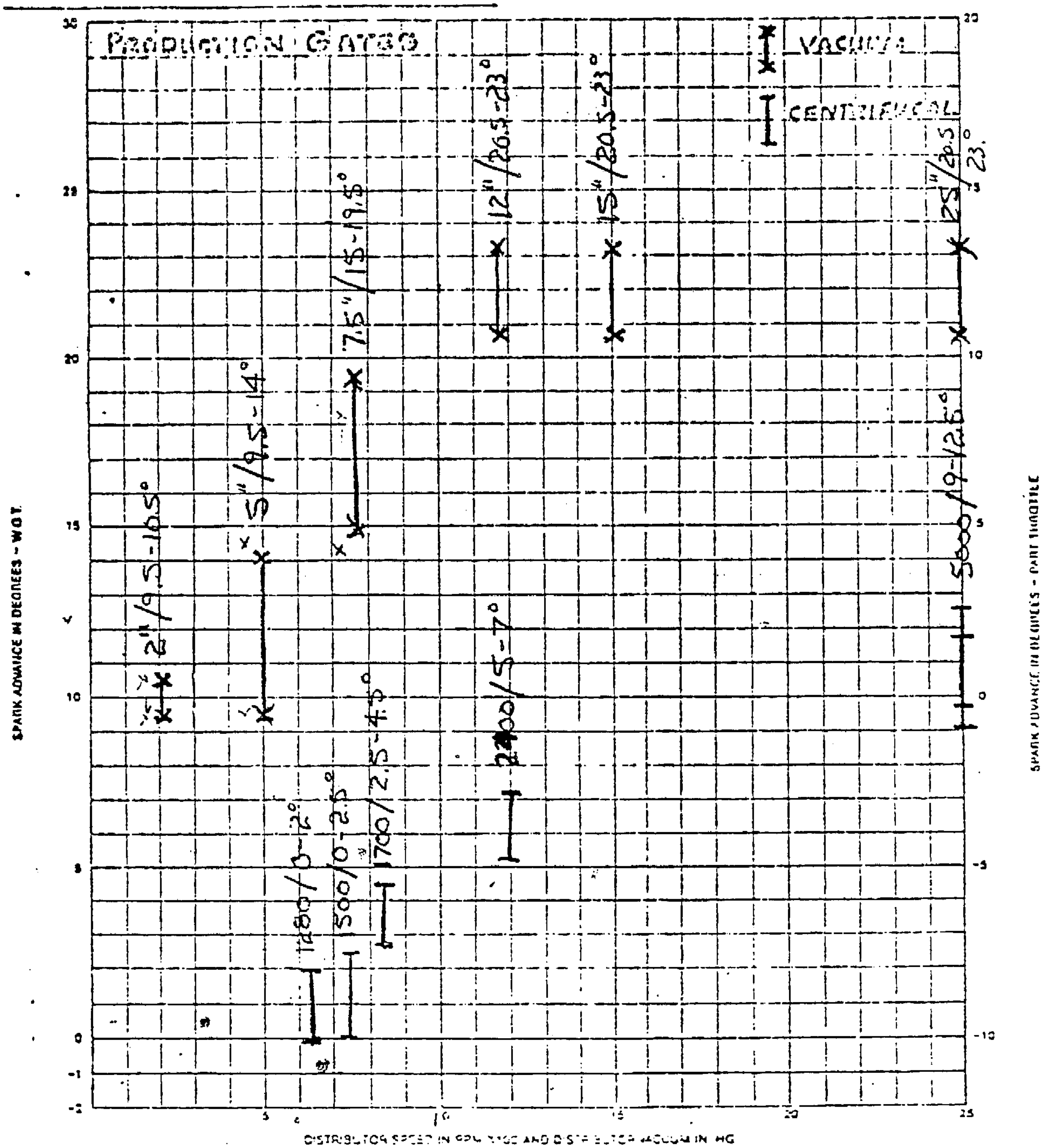
OK

CARB Vehicle No. 16 - 1980 Mercury Cougar

CALIBRATION SPECIFICATION
FORD MOTOR COMPANY

DISTRIBUTOR MAKE FORD
PART NO. EOSE-12127-CA, DA

PRODUCTION GATES



Engine Family: 4.2/5.0 BJC

Issue Date:		10C-1	Page is ☐ Satisfactory ☐ Unsatisfactory
Revised:			Date EPA Rep

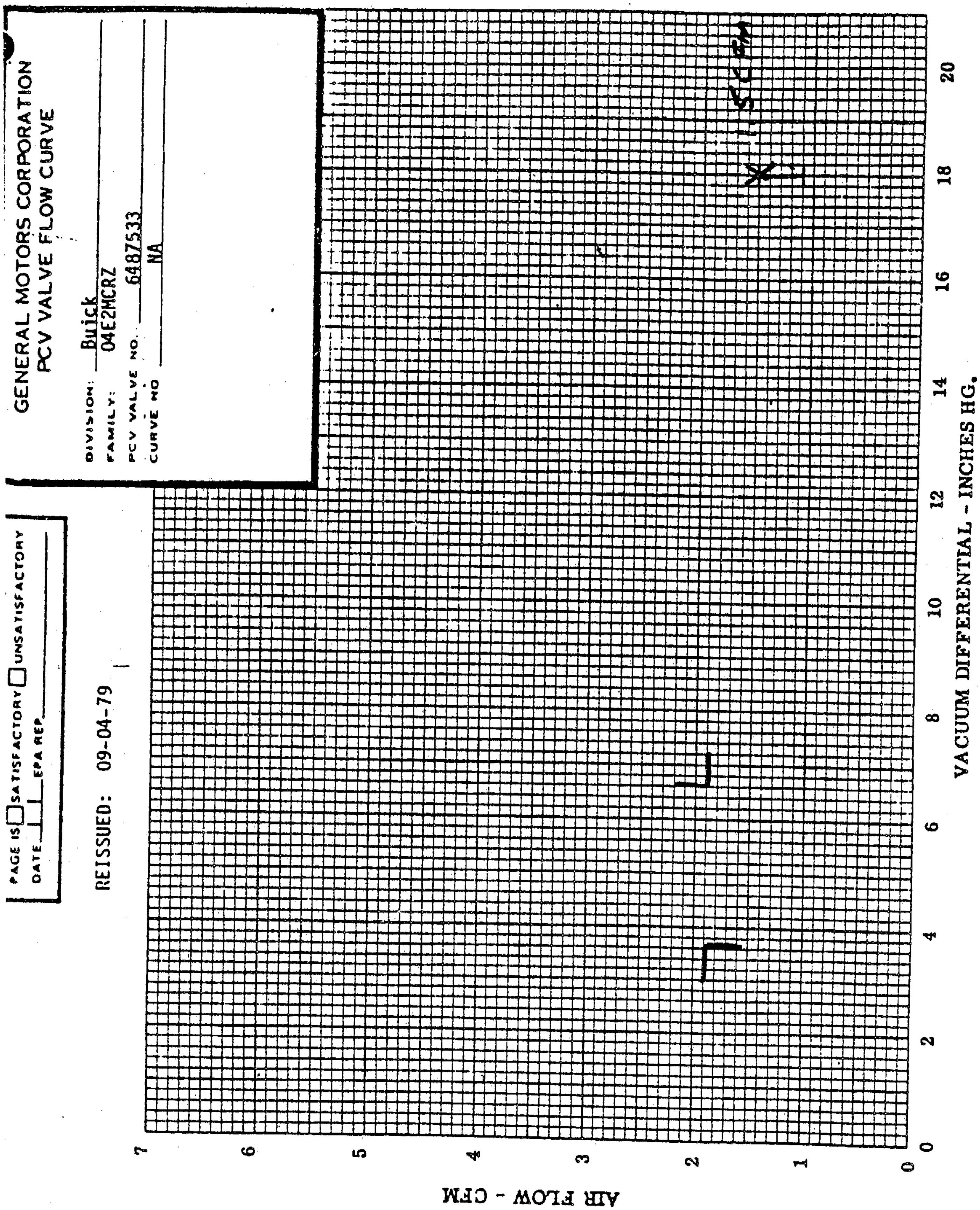
Vehicle No. 17, 1980 Olsmobile Cutlass, 04E2MCRZ

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
Air inlet system				
Fully closed to cold air		30^{o}C min.	32^{o}C	
Fully open to cold air		55^{o}C max.	55^{o}C	
Vac. motor full travel		6.8 - 20.2 kPa	14 kPa	
Distributor	1110784			
Basic Timing		15^{o}BTC @ 800 RPM	10^{o} BTC @ 800 RPM	Reset to spec.
Spark Plug Gap	ACR45TSX	0.060"	0.040"	Reset to spec.
EFE-EGR Thermal Vacuum Switch (EGR Ported)	3033795	120 ± 3^{o}F	124^{o}F	Replaced
EFE-EGR Thermal Vacuum Switch (EFE Manifold)	3033795	120 ± 3^{o}F	126^{o}F	Replaced
EFE Check Valve	460734/497853			One Way Operation
Manifold Air Check Valve	22017158			Functional Check OK
EFE Vacuum Signal	5233320			
Close		7-12" Hg	8" Hg	
Open		1" Hg	1" Hg	
Engine Coolant Sensor	8993298	4114-4743 ohms @ 59^{o}F	6500 ohms @ 59^{o}F	Replaced
		77.7 - 84.0 ohms @ 262^{o}F	30 ohms @ 220^{o}F	
Manifold Absolute Pressure Sensor	25505324			
20 kPa		0.193 - 0.419v	0.28v	
40 kPa		1.321 - 1.451v	1.38v	
60 kPa		2.401 - 2.531v	2.47v	
100 kPa		4.562 - 4.692v	4.57v	

Vehicle No. 17 (Page Two)

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
Low Engine Speed Spark Advance		15^{o}	15^{o}	
Fuel Pump		29.3 - 39.6 kPa	33 kPa	
Idle				
In drive		550 RPM	550 RPM	
A/C on		620 RPM	630 RPM	
Cold idle in park		2200 RPM	2190 RPM	
Thermostat		$195 \pm 2^{o}F$	Would not open @ $212^{o}F$	Replaced

CARB Vehicle No. 17 - 1980 Olds Cutlass



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Rev.12-77 CARB Vehicle No. 17 - 1980 Olds Cutlass

10-04E2MCRZ-120

GM

Division: Buick

Family: 04E2MCRZ

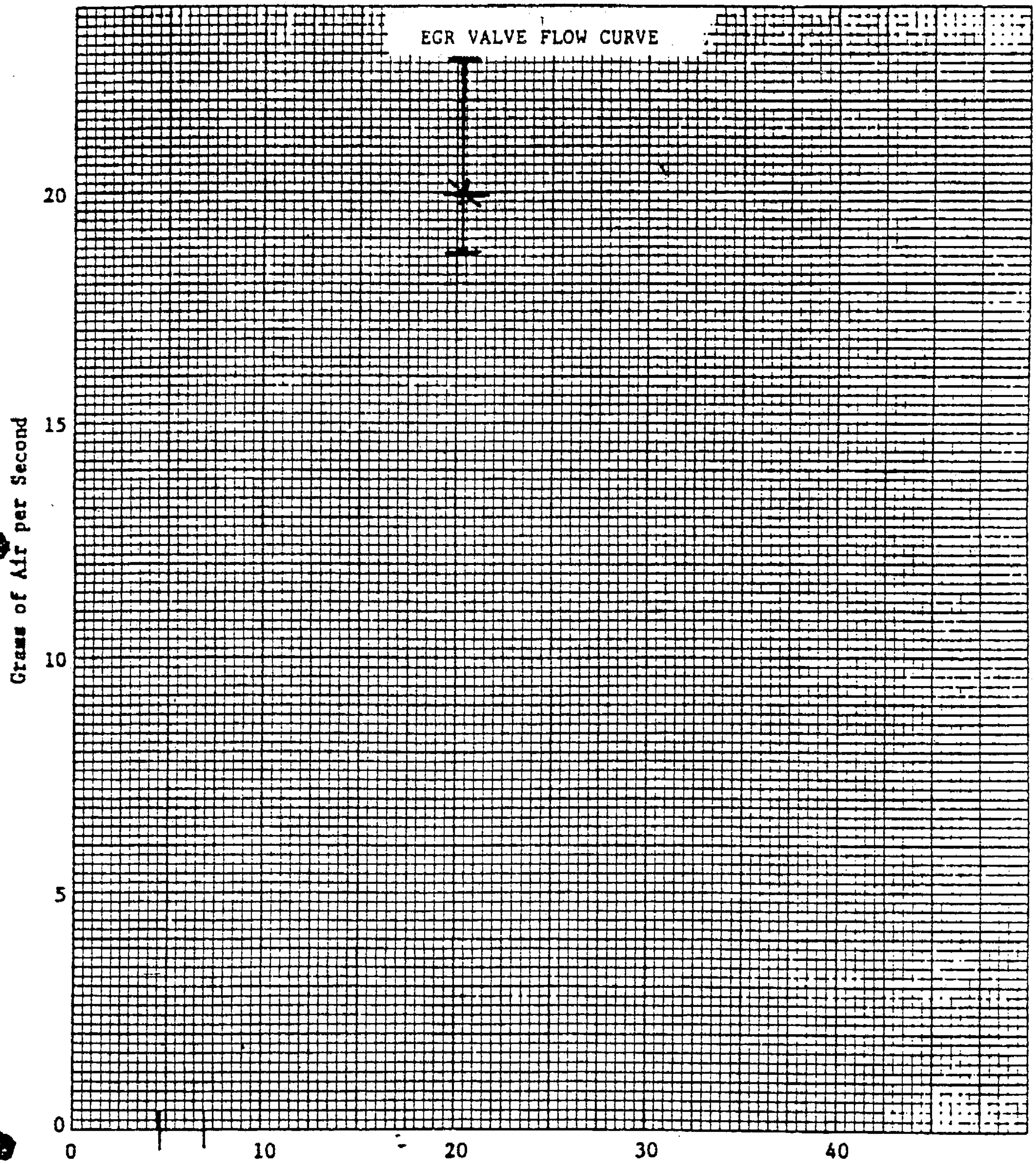
EGR valve no.: 17062861

EGR valve signal: Exhaust Back Pressure/ Ported Vacuum

BP minimum area (mm^2): 103.1-104.6

BP control pressure (kPa): .37 + .11/-.19

Curve number: NA



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REISSUED: 09-04-79 REV. 003

O-2748 Rev. 9-75

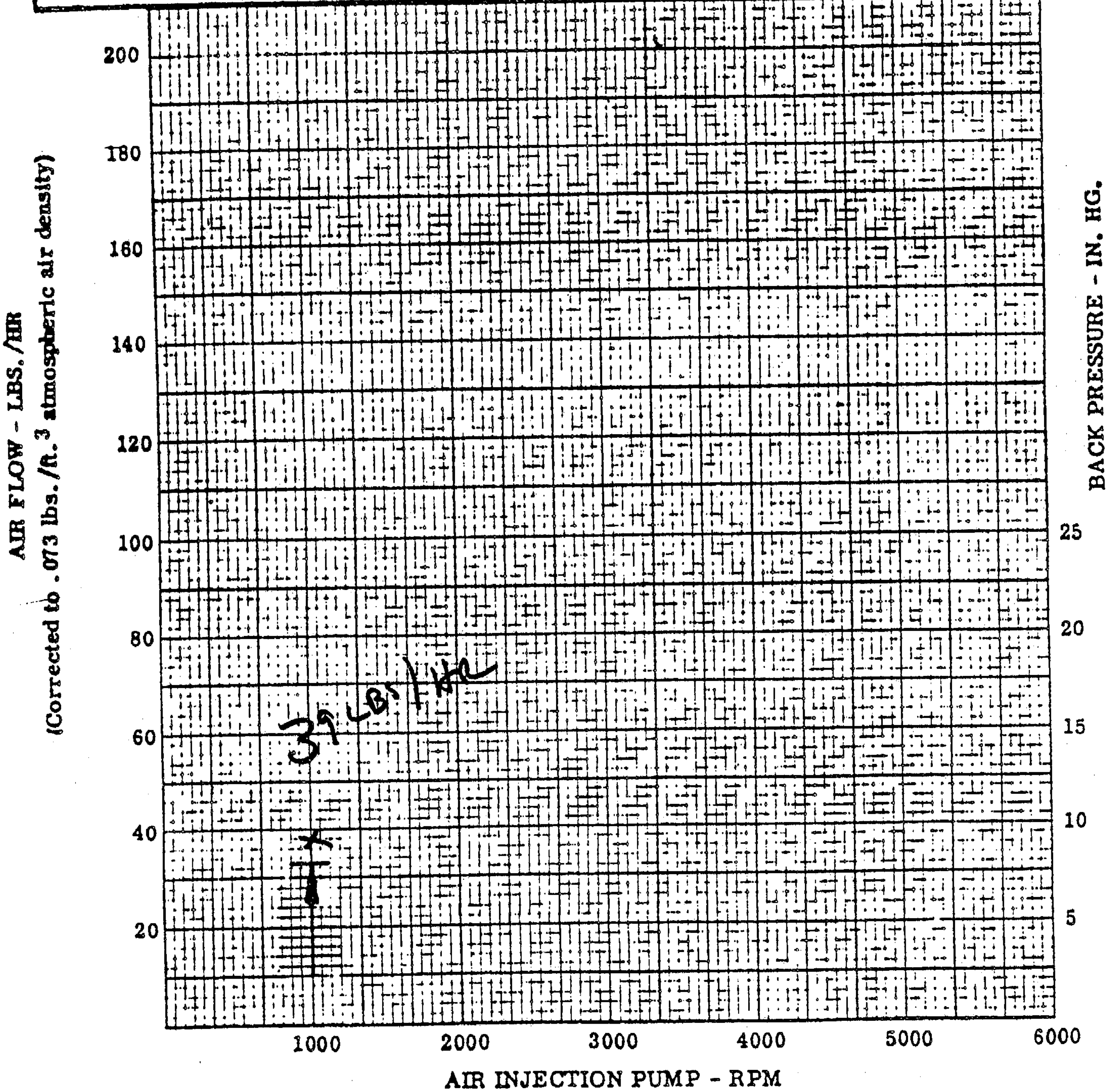
GENERAL MOTORS CORPORATION
AIR PUMP FLOW CURVE

CARB Vehicle No. 17 - 1980 Olds
DIVISION Buick ~~Cutlass~~

FAMILY 04E2MCRZ

PART NO. 7832881

CURVE NO. NA



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REISSUED: 09-04-79

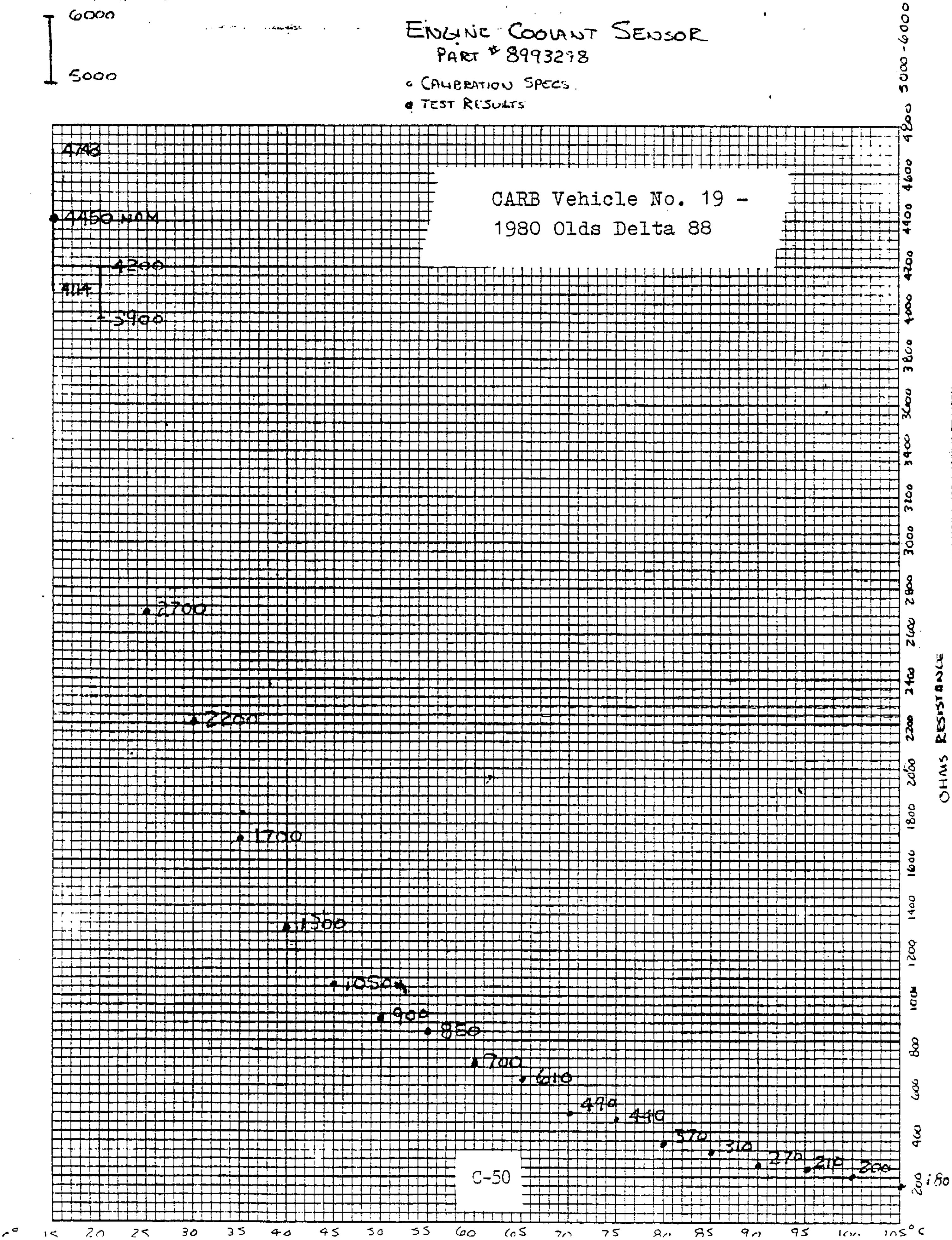
Vehicle No. 19, 1980 Olds Delta 88, 03J4PCZ/OB4S-3

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
Distributor TVS	22506187			Not replaced 5 working days to receive new factory item
Activation		$70 \pm 3^{O}F$	$76^{O}F$	
Deactivation		$61^{O}F$ min.	$60^{O}F$	
Distributor - EGR TVS	3042954			Not replaced 5 working days to receive new factory item.
Activation		$120 \pm 3^{O}F$	$131^{O}F$	
Deactivation		$109^{O}F$ min.	$110^{O}F$	
Vacuum break TVS	22505266			
Activation		$70 \pm 3^{O}F$	$73^{O}F$	
Deactivation		$61^{O}F$ min.	$59^{O}F$	
Thermostat		$192 - 199^{O}F$	$212^{O}F$	Replaced
Canister Purge TVS	3046169			Replaced
Activation		$140 \pm 3^{O}F$	$149^{O}F$	
Deactivation		$133^{O}F$ min.	$136^{O}F$	
Dsitributor Vacuum Delay Valve	22505487	4.8 - 7.2 sec.	5.6 sec.	
Distributor Vacuum Modulator	22505963	8.5 ± .5" Hg	8.2" Hg	
Air Inlet System				
Fully closed to cold air		$30^{O}C$ min.	$33^{O}C$	
Fully open to cold air		$55^{O}C$ min.	$56^{O}C$	
Vac. motor full travel		6.8 - 20.2 kPa	7.9 - 19.5 kPa	
Distributor	1103413			
Basic Timing		18^{O}BTC @ 1100 RPM	18^{O}BTC @ 1100 RPM	
Spark Plug Gap	ACR465X	2.03 mm	2.03 mm	

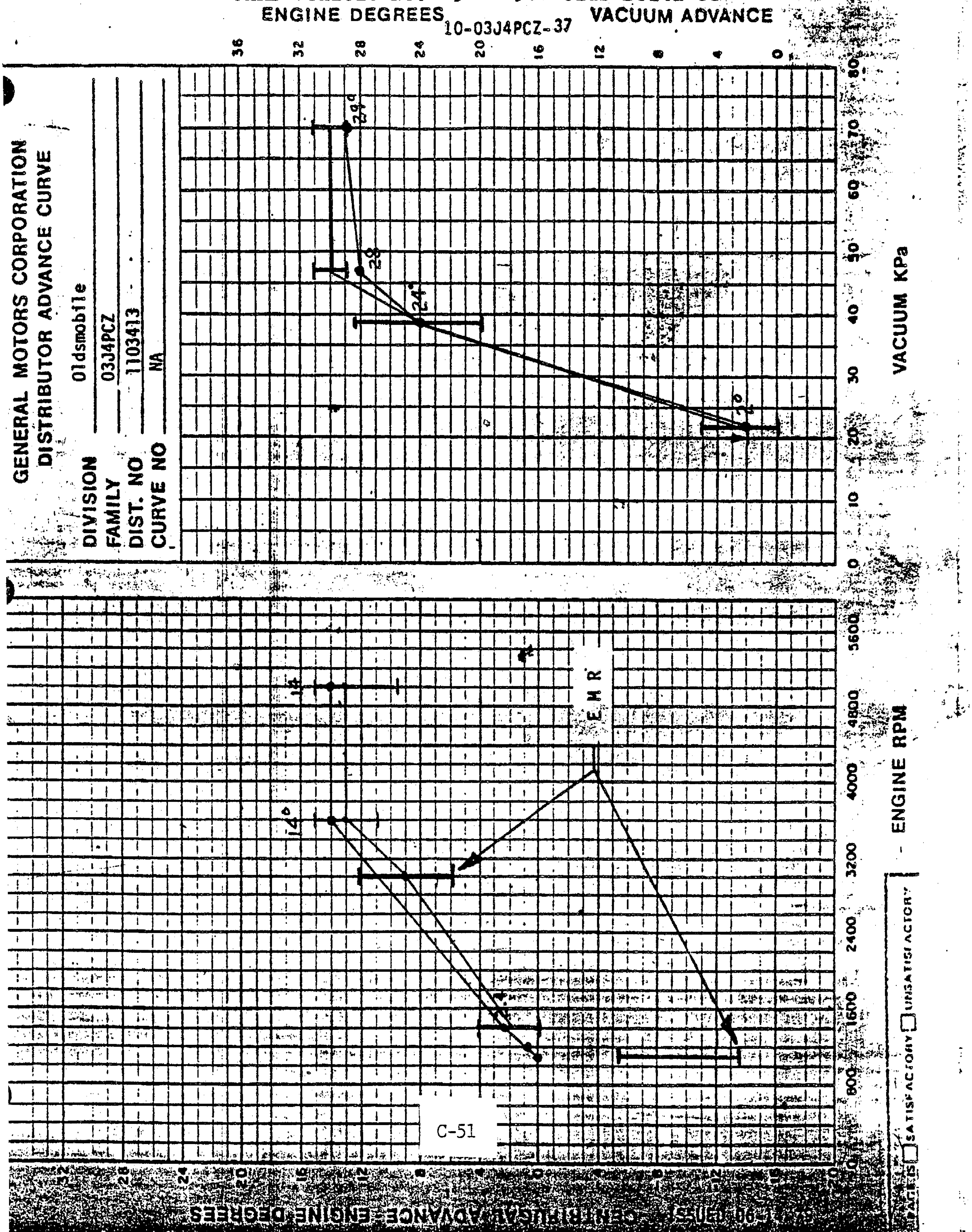
Vehicle No. 19 (Page Two)

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
Engine Coolant Sensor	8993298	4114-4743 ohms @ 15°C	5000-6000 ohms @ 15°C	Measured
		77.7 - 84.0 ohms @ 128°C	80 ohms @ 128°C	Interpolated curve
Fuel Pump Delivery Pressure	6441567	41.4 ± 3.5 kPa	38 - 46 kPa	
Idle Speeds in Drive				
Curb Idle		550 RPM in Drive	550 RPM	
A/C Solenoid Active		650 RPM in Drive	650 RPM	
Fast		700 RPM in Drive	700 RPM	
ECM	16005973			Appears to have been replaced Part No. attached with scotch tape.

CARB Vehicle No. 19 -
1980 Olds Delta 88



CARB Vehicle No. 19 - 1980 Olds Delta 88



CARB Vehicle No. 19 - 1980 Olds Delta 88

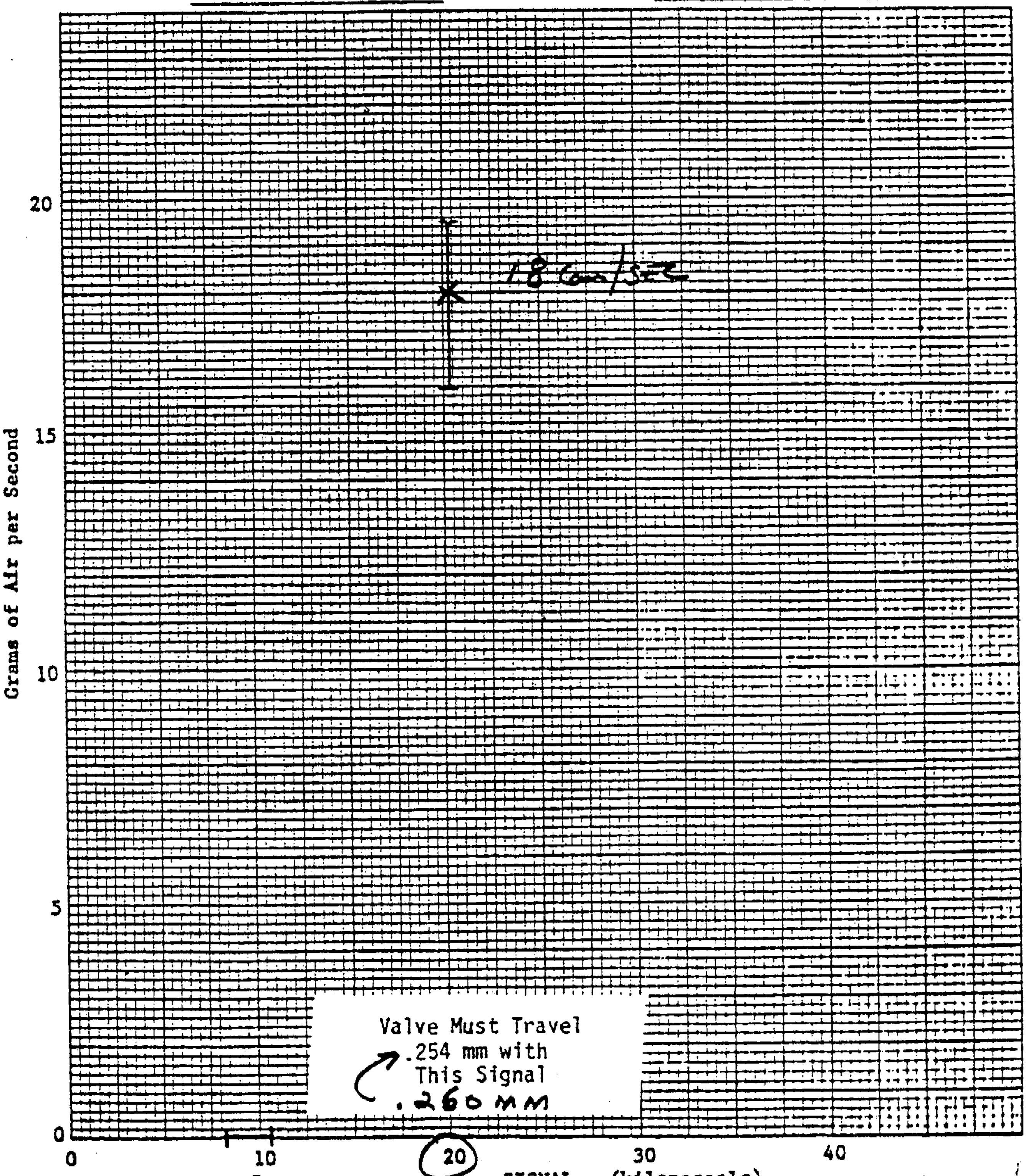
10-03J4PCZ-39

PG-2771-3
Rev.9-77

EGR VALVE FLOW CURVE

GM Division Oldsmobile
Family 03J4PCZ
EGR valve no. 17061580

EGR valve signal B.P. Modulated
BP minimum area (mm^2) 81.8 -83.2
BP control pressure (kPa) .37 +.11/-.19 .45k
Curve number



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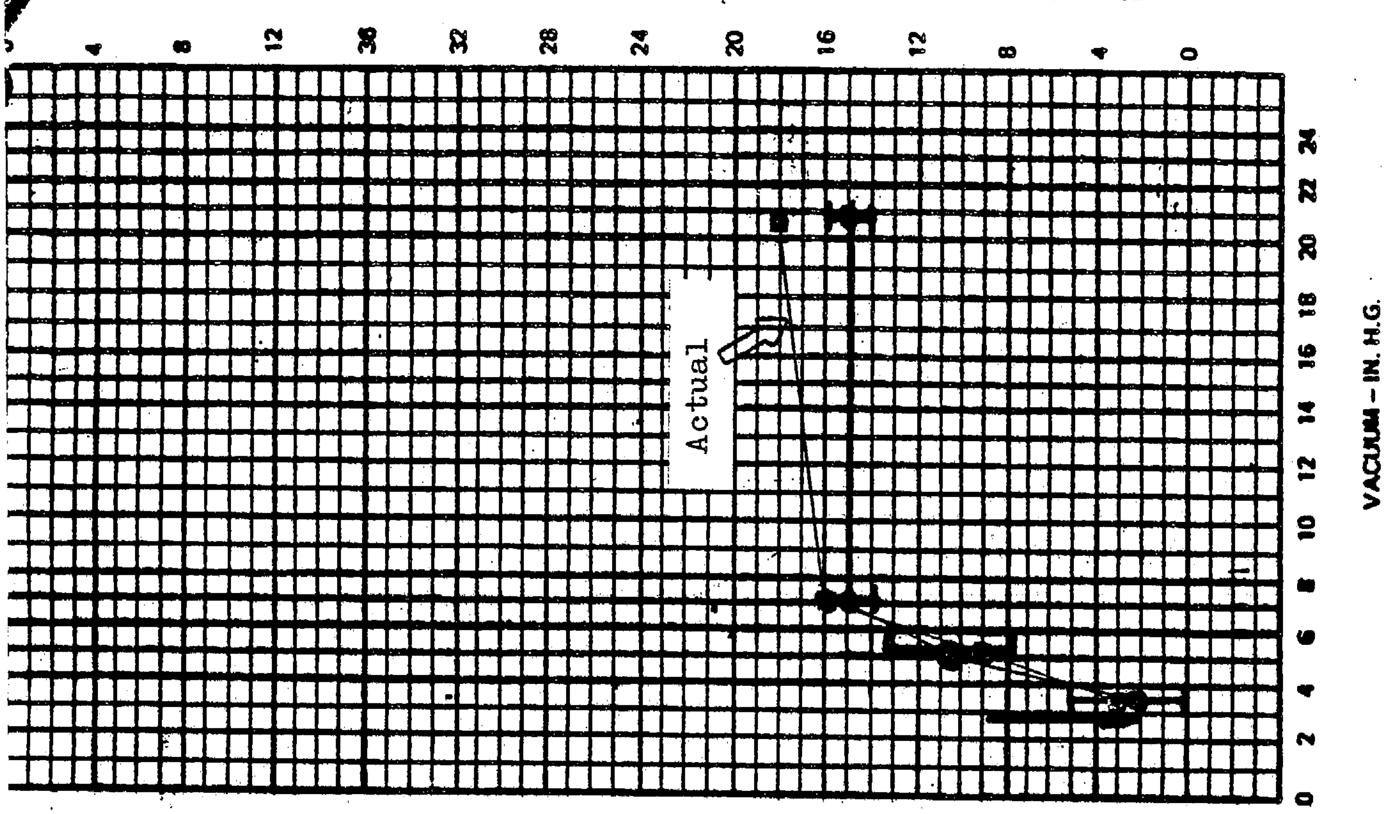
ISSUED: 06-14-79

Vehicle No. 20, 1980 Chevrolet Citation - 2 X 2 NC (2.5L)

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
ECM	16012652			
ECM ROM	Delco 8040 BU			
O_2 Sensor Output			0.0-1.0 volt	
Fuel Pump	6441375			
Delivery Pressure		45-55 kPa	6.7 psi (46 kPa)	
Idle Speeds, RPM				
Carb Idle		700 (D)	650 (D)	Set to 700 (D)
A/C Solenoid Activ.		975 (D)		
Fast Idle		2600 (P)	2500 (P)	
Carburetor	17059727			
Carburetor Solenoid Dwell		10^{o}-50^{o} on 60^{o} Scale	5^{o}-20^{o} @ 650 RPM 25^{o}-35^{o} @ 2500 RPM	After mixture adjust (below) 15^{o}-35^{o} @ 700 RPM 30^{o}-40^{o} @ 3000 RPM
Carburetor Mix		Bench Setting Specs		After adjustment
Idle Air Bleed		3 turns from light seat	1½ turns	3 turns
Lean Mixture		2½ turns	2¼ turns	4 turns
Idle Mixture		5 turns	3½ turns	4¼ turns
Rich Mixture		No spec	1¼ turns	1¼ turns
Distributor	1110569			
Basic Timing		10^{o} BTC @ 700 RPM or less	10^{o} BTC @ 650 RPM	
Spark Plug	R44TSX			
Plug Gap		0.060 in.	0.060 in.	

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
Vehicle No. 20 - Page Two				
Vac. Control Sw. "A"	10007036			
Activation Value		8.5 $\pm$ .7 in Hg (Vac Decr)	8.0 in Hg (Decr)	
Deactivation Value		9.0 $\pm$ .7 in Hg (Vac Incr)	8.3 in Hg (Incr)	
EGR	17064815			Functional Check OK
Thermostat	3042805	Open at 195^{o}F	168^{o}F	Replaced. New part opens at 189^{o}F

10-02X2NC-53C



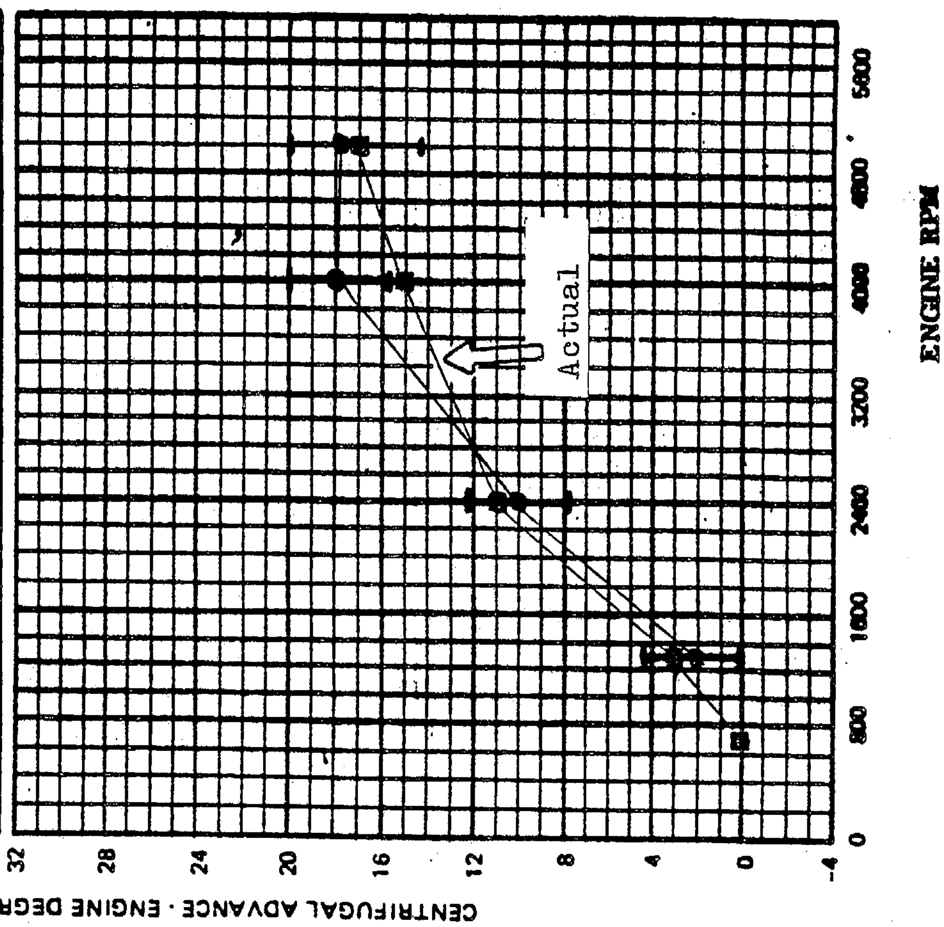
GENERAL MOTORS CORPORATION
DISTRIBUTOR ADVANCE CURVE

CARB Vehicle No. 20 – 1980 Chev. Citation

DIVISION: Pontiac
FAMILY: 02X2NC Engine Codes 1B,2B
DIST. NO.: 1110559

● VEHICLE TEST DATA
● CALIBRATION SPECIFICATION DATA

ISSUED: 003



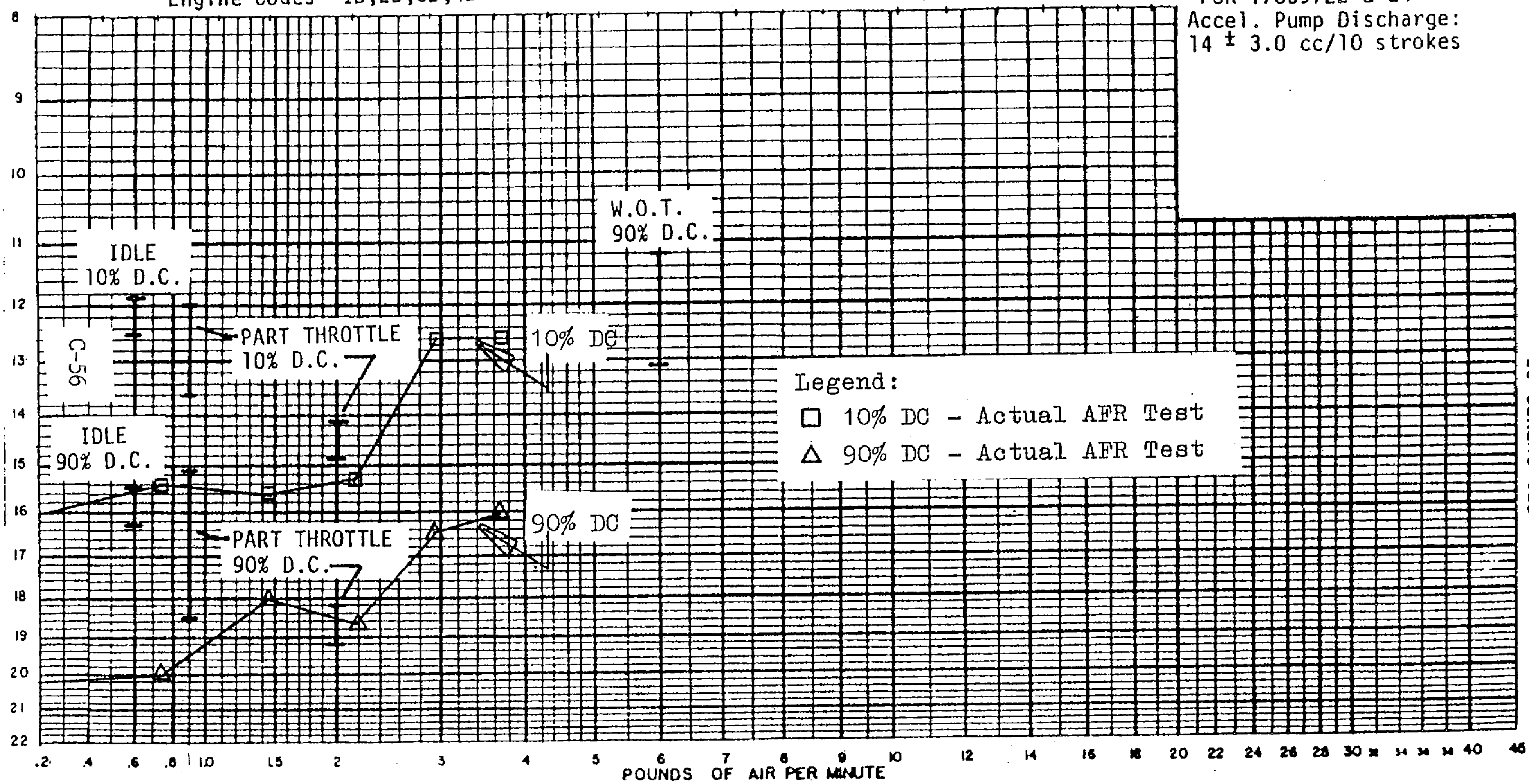
CARB Vehicle No. 20 - 1980 Chev. Citation **CARBURETOR FLOW CURVE**

GM Division Pontiac Carburetor No. 17059721, 17059722, 17059723, 17059724

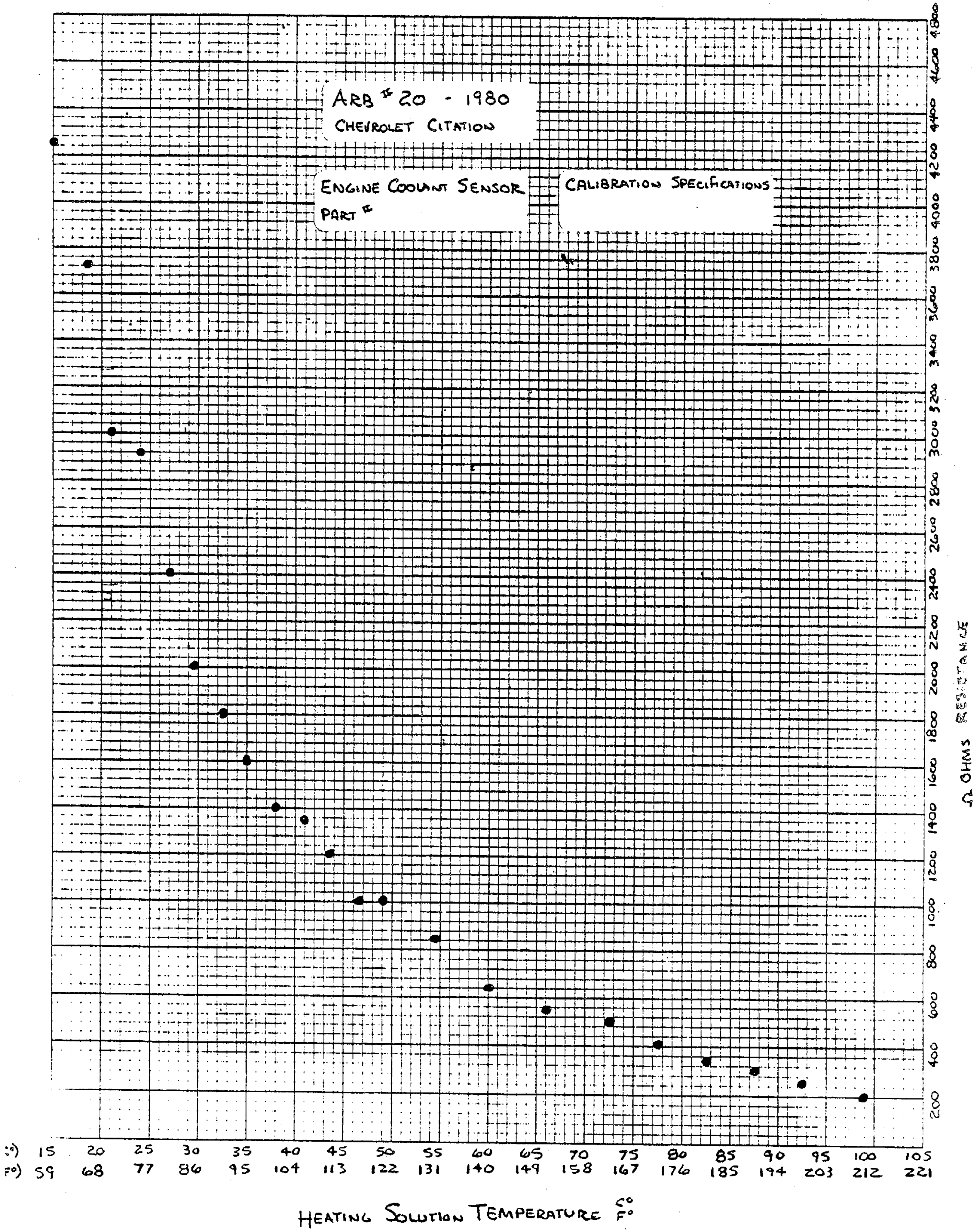
Family 02X2NC

Engine Codes 1B,2B,3B,4B

FOR 17059721 & 23
Accel. Pump Discharge:
17 ± 3.0 cc/10 strokes
FOR 17059722 & 24
Accel. Pump Discharge:
14 ± 3.0 cc/10 strokes



ISSUED: 003
REVISED: 004


ARB # 20 - 1980
CHEVROLET CITATION
ENGINE COOLANT SENSOR
PART #
CALIBRATION SPECIFICATIONS
Ω OHMS RESISTANCE
4800 4600 4400 4200 4000 3800 3600 3400 3200 3000 2800 2600 2400 2200 2000 1800 1600 1400 1200 1000 800 600 400 200
(C°) 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105
(F°) 59 68 77 86 95 104 113 122 131 140 149 158 167 176 185 194 203 212 221
HEATING SOLUTION TEMPERATURE C° F°

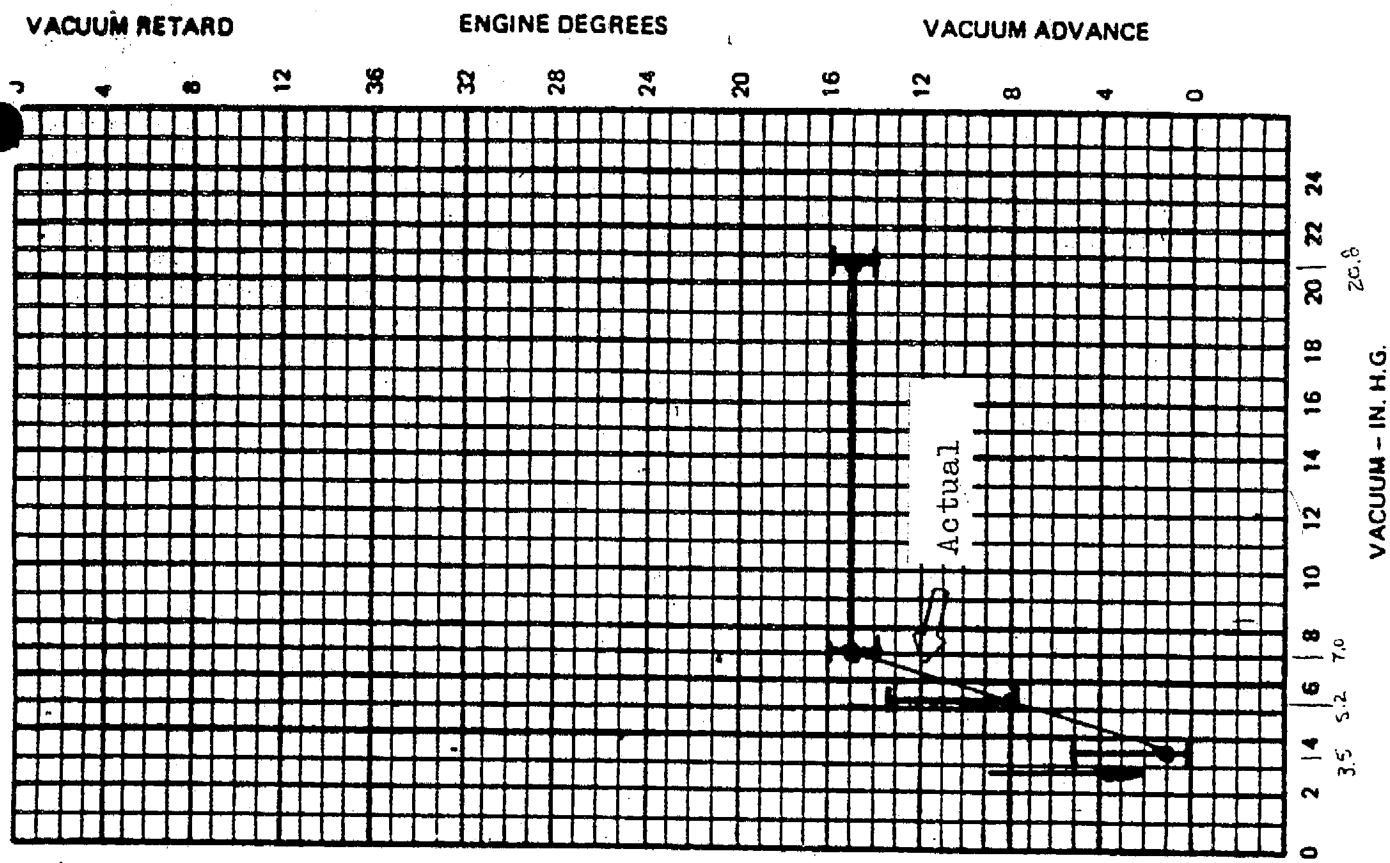
Vehicle No. 21 - 1980 Oldsmobile Omega - 2 X 2 NC (2.5L)

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
ECM	16012652			
ECM ROM	Delco 3040 BU			Difficult to read. Could be 8040 BU
O_2 Sensor Output			0.0-0.7 Volt	
Fuel Pump Delivery Pressure		45-55 kPa		Within spec. Not recorded.
Idle Speeds, RPM				
Curb Idle		700(D)	700(D)	
A/C Solenoid Activ.		975(D)	975(D)	
Fast Idle		2600(P)	2600(P)	
Carburetor	17059724			
Carburetor Solenoid Dwell		10°-50° on 60° Scale	5° Fixed	Vacuum hose to air cleaner bimetal sensor off. Replaced. Dwell then varying 15° to 35°.
Distributor	1110569			
Basic Timing		10° BTC @ 700 RPM or less	10° @ 700 RPM	
Spark Plugs	R44TSX			
Plug Gap		0.060 in.	0.060 in.	

Vehicle No. 21 - Page Two

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
Two Port EGR TVS	3046782			
Activation Value		$135^{o} \pm 5^{o}$ F	133^{o} F	Not replaced
Deactivation Value		120^{o}F min.	118^{o}F	
Three Port Distrib. TVS	3039246			
Activation Value		$120^{o} \pm 5^{o}$F	110^{o}F	Replaced
Deactivation Value		110^{o}F	100^{o}F	
Distributor Vacuum Delay Valve	527011			
Activation Value		Sudden Vac. Decrease	OK	
Deactivation Value		0-15 in Hg in 6.4 to 9.6 seconds	0-15 in Hg in 7.0 seconds	
Vacuum Switch Vacuum Delay Valve	10014191			
Activation Value		Sudden Vac. Decrease	OK	
Deactivation Value		0-15 in Hg in 7.0 to 11.5 seconds	0-15 in Hg in 10 seconds	
Deceleration Valve	10005152			
Activation Value		Sudden Vac Increase	Between 1 & 2 sec. @ 500 mm Hg	
Deactivation Value		Vacuum Decrease	OK	
Vacuum Control Sw. "B"	10007036			
Activation Value		$5.0 \pm .7$ in Hg (Vac Decr)	4.5 in Hg (Decr)	Not replaced
Deactivation Value		$5.5 \mp .7$ in Hg (Vac Incr)	4.5 in Hg (Incr)	
Vacuum Control Sw. "A"	10007036			
Activation Value		$8.5 \pm .7$ in Hg (Vac Decr)	8.5 in Hg (Decr)	
Deactivation Value		$9.0 \mp .7$ in Hg (Vac Incr)	9.0 in Hg (Incr)	
EGR	17064815			Functional Check OK
Thermostat		Open at 195^{o}F	Starts to open 184^{o}F	

10-02X2NC-53C



GENERAL MOTORS CORPORATION
DISTRIBUTOR ADVANCE CURVE

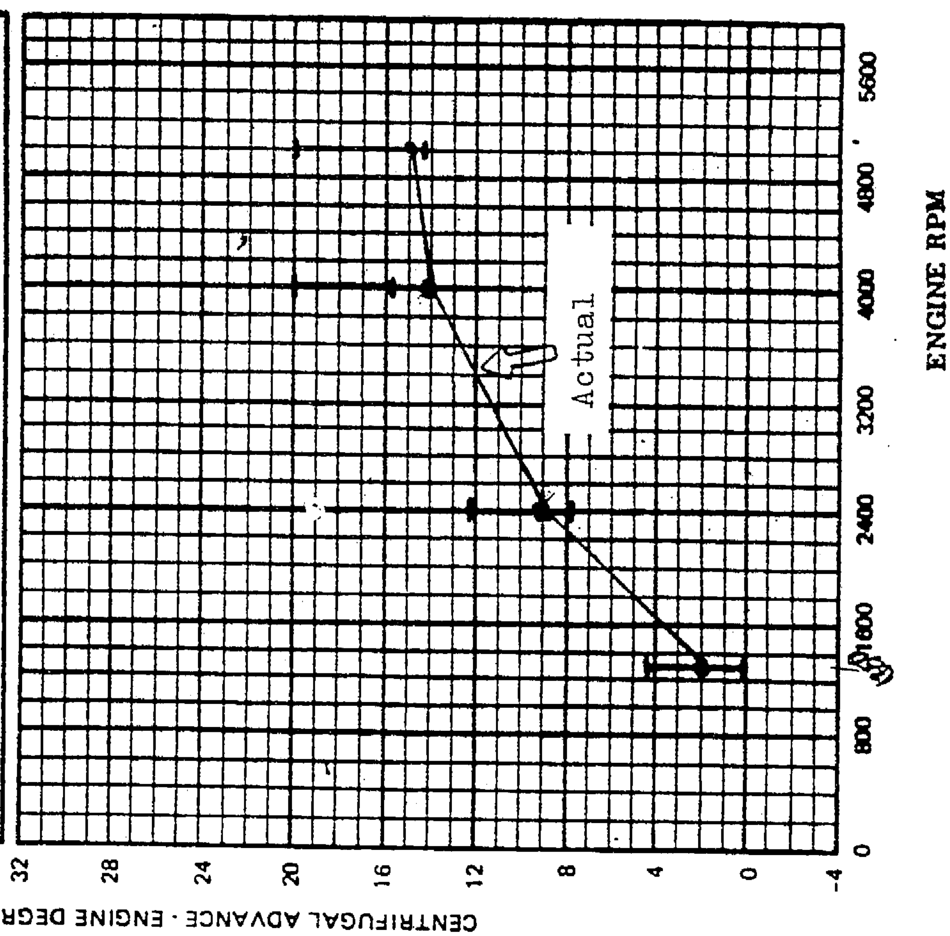
CARB Vehicle No. 21 - Olds Omega

DIVISION Pontiac

FAMILY: 02X2NC Engine Codes 1B,2B

DIST. NO.: 1110569

ISSUED: 003



Vehicle No. 22 - BMW 528i - BMW 128.8

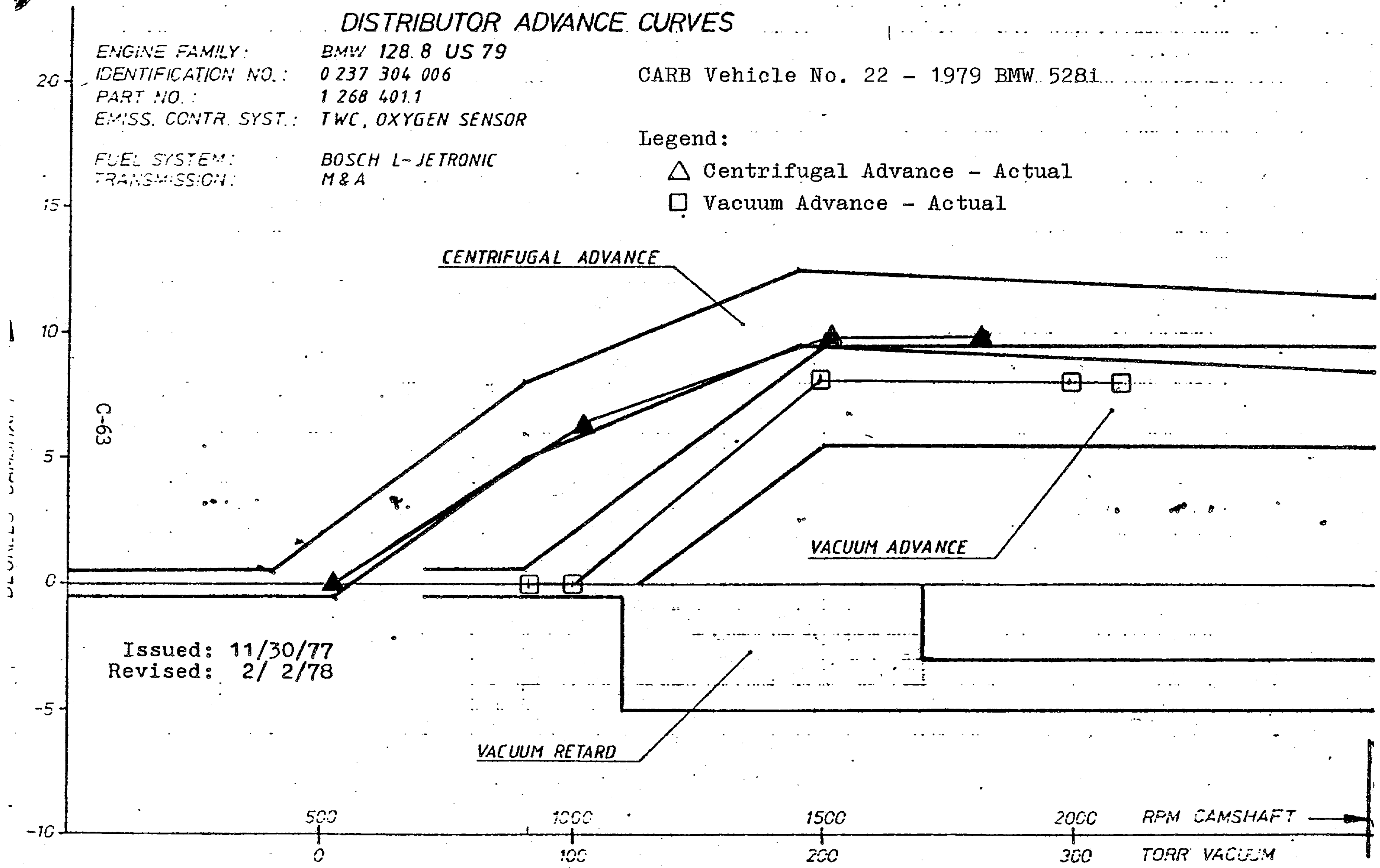
ITEM	SPEC	ACTUAL	REMARKS
Thermostat	Start to Open $176^{\circ} \pm 2.5^{\circ}F$	Start $174^{\circ}F$ Fully Open $179^{\circ}F$	
Engine Idle Speed	800 ± 100 RPM	1000 RPM	Reset to 950 RPM
Ignition System			
Initial Timing	22° BTDC @ 2100 RPM	22° @ 2350 RPM	Set to 22° @ 2100 RPM
Spark Plug Gap	.0236 in - .0275 in.	.030 in.	Set to .028 in.
Dwell	$42^{\circ} \pm 10^{\circ}$ @ 1500 RPM $52^{\circ} \pm 5^{\circ}$ @ 4500 RPM	42.2° @ 1500 RPM 48.6° @ 4500 RPM	
Temperature Sensor T_1	7-12K ohms @ $14^{\circ}F$ 2-3K ohms @ $68^{\circ}F$ 600-1000 ohms @ $122^{\circ}F$ 250-400 ohms @ $176^{\circ}F$	11.5K ohms @ $14^{\circ}F$ 2.5K ohms @ $68^{\circ}F$ 800 ohms @ $122^{\circ}F$ 305 ohms @ $176^{\circ}F$ 1.5 volts output	
Thermo-Time Switch			
"G" to ground	25-40 ohms below $86^{\circ}F$ 50-80 ohms above $104^{\circ}F$	34 ohms 68 ohms	Bosch Procedure Bosch Design No. $35^{\circ}C/8s$
"W" to ground	0 ohms below $86^{\circ}F$ 100-160 ohms above $104^{\circ}F$	0 ohms 130 ohms	
"G" to "W"	25-40 ohms below $86^{\circ}F$ 50-80 ohms above $104^{\circ}F$	32 ohms 61 ohms	
Distributor Advance Thermoswitch	Open $107.6^{\circ}F$ to $118.4^{\circ}F$	Open @ $104^{\circ}F$	Replaced. New unit open above $108^{\circ}F$
Fuel Injection			
Operating Pressure	1.7 to 2.7 bar	2.2-2.6 bar	
Cold Start Valve			Procedure not available. Several test methods attempted without success.

Vehicle No. 22 - Page Two

ITEM	SPEC	ACTUAL	REMARKS
Air Flow Meter Mixture	0.2 to 0.8% CO	0.1% CO	Air Flow Meter Plug Missing Adjusted to 0.35% CO (Test 1) Reset to 0.50% CO (Test 2)
Temperature Sensor T_2		5.0 volts output	Not removable to test
O_2 Sensor Rich Condition Lean Condition	 Approx. 625 mv Approx. 175 mv	 750mv 250mv	Activates 78 seconds after cold start

ENGINEERING EMISSION CONTROL

DISTRIBUTOR ADVANCE CURVES



EM-G 10.77

ENGINEERING EMISSION CONTROL

CARB Vehicle No. 22 - 1979 BMW 528i

5-D-10

Engine Family 128.8

Setting Procedure

1. Checking and Adjustment of Ignition Timing

Engine at normal operating temperature. Detach vacuum hoses from the vacuum unit on the distributor. Connect Siemens-Ignition Tester to the test plug.

Loosen the distributor clamp bolt.

Start engine and adjust engine speed to 2100 rev./min. Read out ignition timing on Siemens-Tester.

Turn distributor in the correct direction to bring the ignition timing to the correct value at $22^\circ \pm 1^\circ$ BTDC.

Tighten the distributor clamp bolt and check ignition timing and engine speed again.

Reconnect vacuum hoses to unit on distributor.

OTHER DOCUMENTS IN THIS PACKAGE DATED 2/2/78.

2. Adjustment of Engine Idling Speed and CO

Run engine at normal operating temperature. Connect CO-tester to test plug at the exhaust manifold and connect rev.-counter.

The correct idle speed is 900 ± 100 rev./min. By turning the air screw on the throttle butterfly manifold adjust engine speed to the correct value.

Pull off the vacuum hose line between carbon canister and intake manifold and keep it open.

Read out CO value on CO-tester. The correct value is between 0.2% and 0.8% by volume. Disconnect oxygen sensor connection plug and check CO again on CO-tester. The read-out should be equal to the indicated value with connected oxygen sensor.

Set up this value by turning the air by-pass screw on the air flow meter when engine is idling.

Reconnect oxygen sensor plug and vacuum hose between carbon canister and intake manifold.

Adjustment of idle speed and idle CO content

When checking or adjusting idle speed and idle CO content follow the below procedures.

Idle speed adjustment

Connect a BMW programtester, BMW digitaltester or simple a revolution counter to the engine, start engine and check idle speed.
The correct idle speed is 900 ± 100 rpm.

If an adjustment is necessary do it by turning idle speed adjusting screw at throttle valve.

Idle CO-content adjustment

Pull off purge line between carbon canister and air collector and seal opening of the air collector.
Remove idle test hole plug at rear exhaust manifold and connect CO-meter. Start the engine.
Measure idle CO-content. The idle CO value must be 0.2 - 0.7 vol.%
Disconnect plug connection of Lambda-sensor from ECU of the fuel injection system (located in the engine compartment on right side of the dash panel).
The idle CO value must not change.
If a deviation is indicated adjust it at CO-adjusting screw in lower side of the air flow meter.

Important: The engine must not run at idle speed too long, otherwise there is danger of overheating. Place a fan in front of the car if extended adjustment work is necessary.

If the idle CO content is too low after disconnecting Lambda sensor, find out whether the intake system behind the air flow meter is absolutely airtight.

FROM SERVICE INFORMATION PACKAGE
DATED JULY 78.

Vehicle No. 23, 1980 Ford Thunderbird - 4.2/5.0 BJC

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
Calibration No.		0-11N-RO-S25		Revision No. Factory Printed RO. Manual attempt to change to R10 unclear.
Carburetor		E04E-9510-EA	E04E-9510-VA	OK if Rev No. really R10
Carburetor Measurements				
Float level (Wet Set)			13/16"	The following are within tune-up manual specifications
Accel Pump Set			No. 2	
Choke Setting		3 Rich	3 Rich	
Choke Pull Down Rod			Std.	
Distributor	EOSE-12127-CA			
Emission Sticker			EOSE-9C485 MA/BPG	Manually changed from CA/BJD
Spark Plug	ASF-52	0.048-0.052"	Varied 0.040" to 0.043"	Reset to 0.050"
Basic Timing		6^{o} BTDC @ 500 RPM(N)	6^{o}BTDC @ 500 RPM(N)	
Curb Idle-AC Off.		500 RPM(D)	500 RPM(D)	
Fast Idle		2100(N)		Cold start fast idle 1400 RPM, increasing to 2000 RPM at about 2 min. Distrib. vac came on at this time. Set to 2100 RPM on high step.

Vehicle No. 23 (Continued)

ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
Fuel Pump Press.		6.0 to 7.5 psi @ 200 RPM	7.5 psi @ 2000 RPM	
Dashpot, Throttle Sol. Positioner		1.0 to 2.0 sec to close	1.6 sec	
Electrically Heated Choke		1.17 to 1.23^{o} defl. per ^{o}F		Unable to measure
Air Cleaner Duct & Valve Vac Motor		Heat on above 9 in. Hg. Heat off below 4 in. Hg.	9.1 in. Hg. 4.0 in. Hg.	
Air Cleaner Bi-metal Sensor		Temp 90^{o}F Output Vac 4 to 9 in. Hg.	86^{o}F 6 in. Hg.	
Air Cleaner Cold Weather Modulator		Closed below 40^{o}F Open above 55^{o}F	40^{o}F 45^{o}F	Replaced. New part closed below 39^{o}F, open above 57^{o}F
Vac. Regulator Valve Output Vacuum		8.0 $\pm$ 0.5 in: Hg.	Test 1: 8.5 to 8.7 in. Hg. Test 2:8.1 in. Hg.	Retested OK after other repairs completed
Vac. Control Valve, 3 port Start to Open No Flow Above		220^{o} to 230^{o}F 10 SCCM below 200^{o}F	227^{o}F No Flow @ 200^{o}F	
Vac. Control Valve, 4-Port, Vac to Dist. Bottom Ports Flow Top Ports Flow No Flow Above		90^{o} to 100^{o}F By 105^{o}F 10 SCCM below 80^{o}F	96^{o}F 106^{o}F No Flow @ 80^{o}F	

Vehicle No. 23 (Continued)

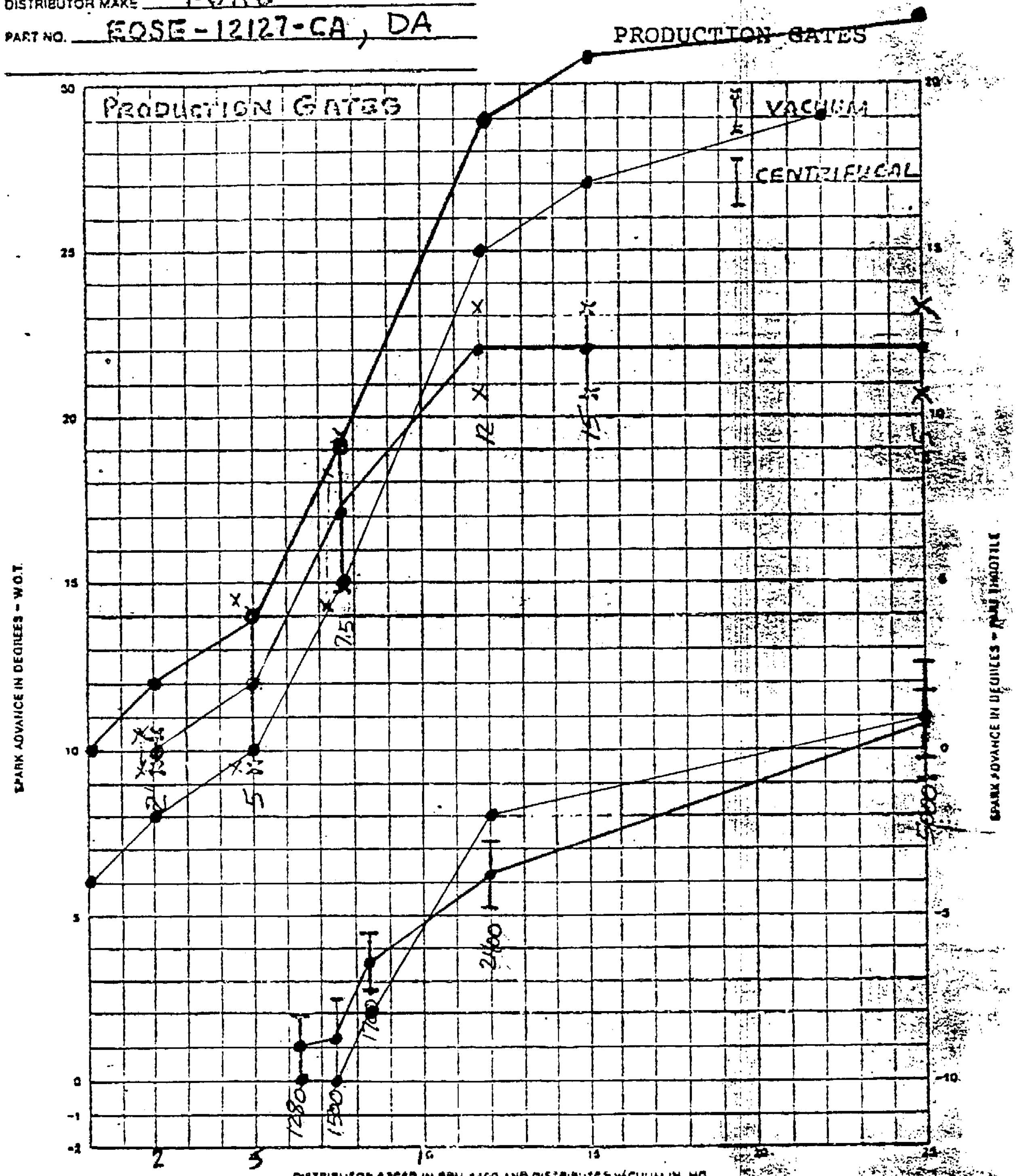
ITEM	PART NO.	SPEC.	ACTUAL	REMARKS
Air Cleaner Temp Vac Switch		Open above 76°F Closed below 50°F	78°F 50°F	
Vac Retard Delay Valve		375 $\pm$ 75 sec.		One way operation functional check OK per factory shop manual.
Vac Delay Valve, Vac to Air Control Bypass Valve		20 $\pm$ 4 sec.	Reverse Installation	Installation corrected. One way operation functional check OK per factory shop manual.
Vac Control Valve, 2 Port				
Start to Flow		123° to 133°F	126°F	
No Flow Above		10 SCCM Below 103°F	No Flow @ 103°F	
Vac Delay Valve, Vac to Purge CV		Not listed but shown in vacuum schematic 10A-2.1		One way operation functional check OK per factory shop manual.

Vehicle No. 23

DISTRIBUTOR PERFORMANCE CURVE
TEST #1 - SEE ALSO: TEST #2 AFTER REPAIR

CALIBRATION SPECIFICATION
FORD MOTOR COMPANY

DISTRIBUTOR MAKE FORD
PART NO. EOSE-12127-CA, DA



Engine Family: 4.2/5.0 BJC

10C-1 C-70

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Date EPA Rep

Issue Date: JUL 29 79

Vehicle No. 23

2

DISTRIBUTOR PERFORMANCE CURVE

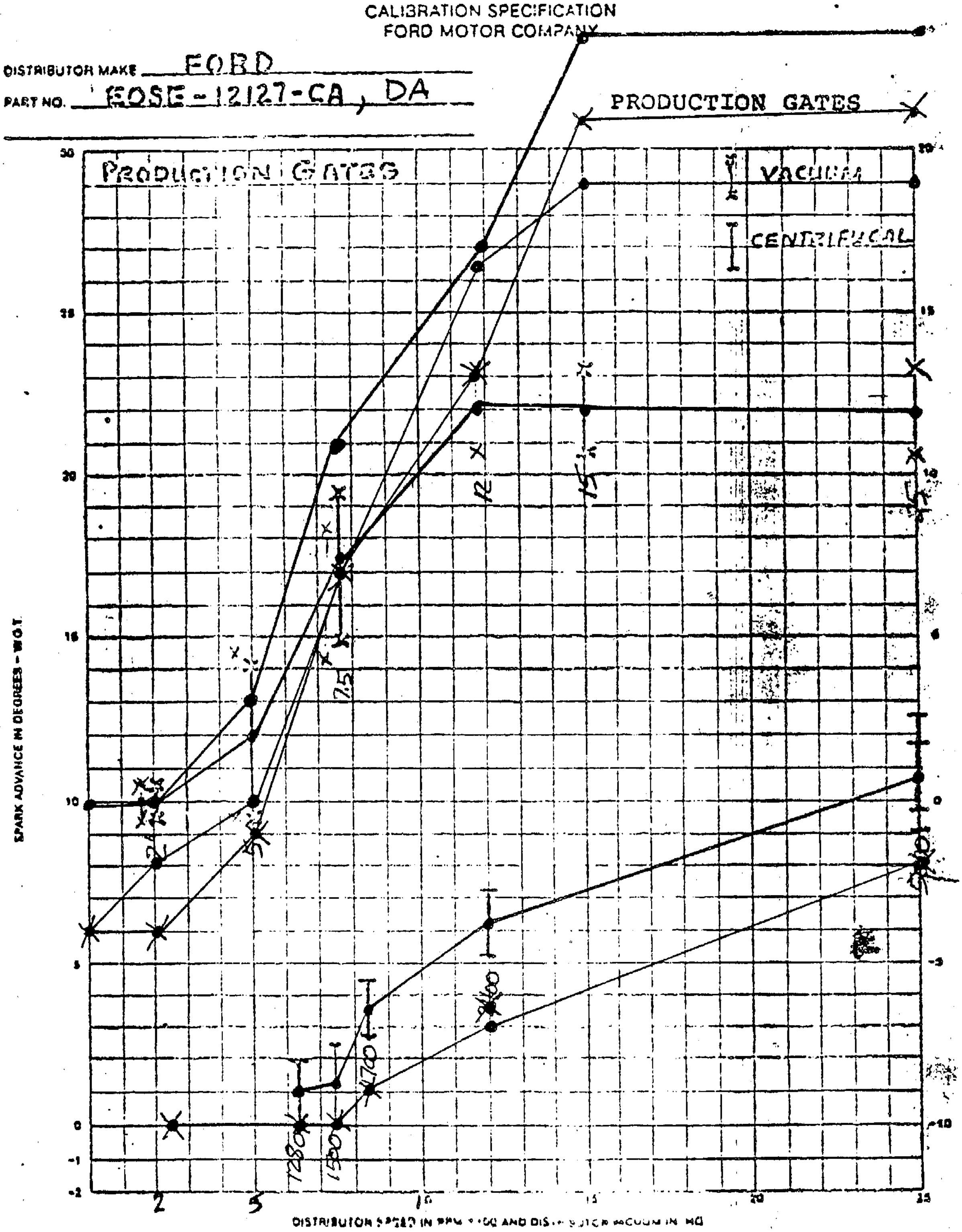
TEST #2 AFTER REPAIR

TEST #3 W/SNAP ON TIMING LIGHT

CALIBRATION SPECIFICATION
FORD MOTOR COMPANY

DISTRIBUTOR MAKE FORD

PART NO. EOSE-12127-CA, DA



Engine Family: 4.2/5.0 BJC

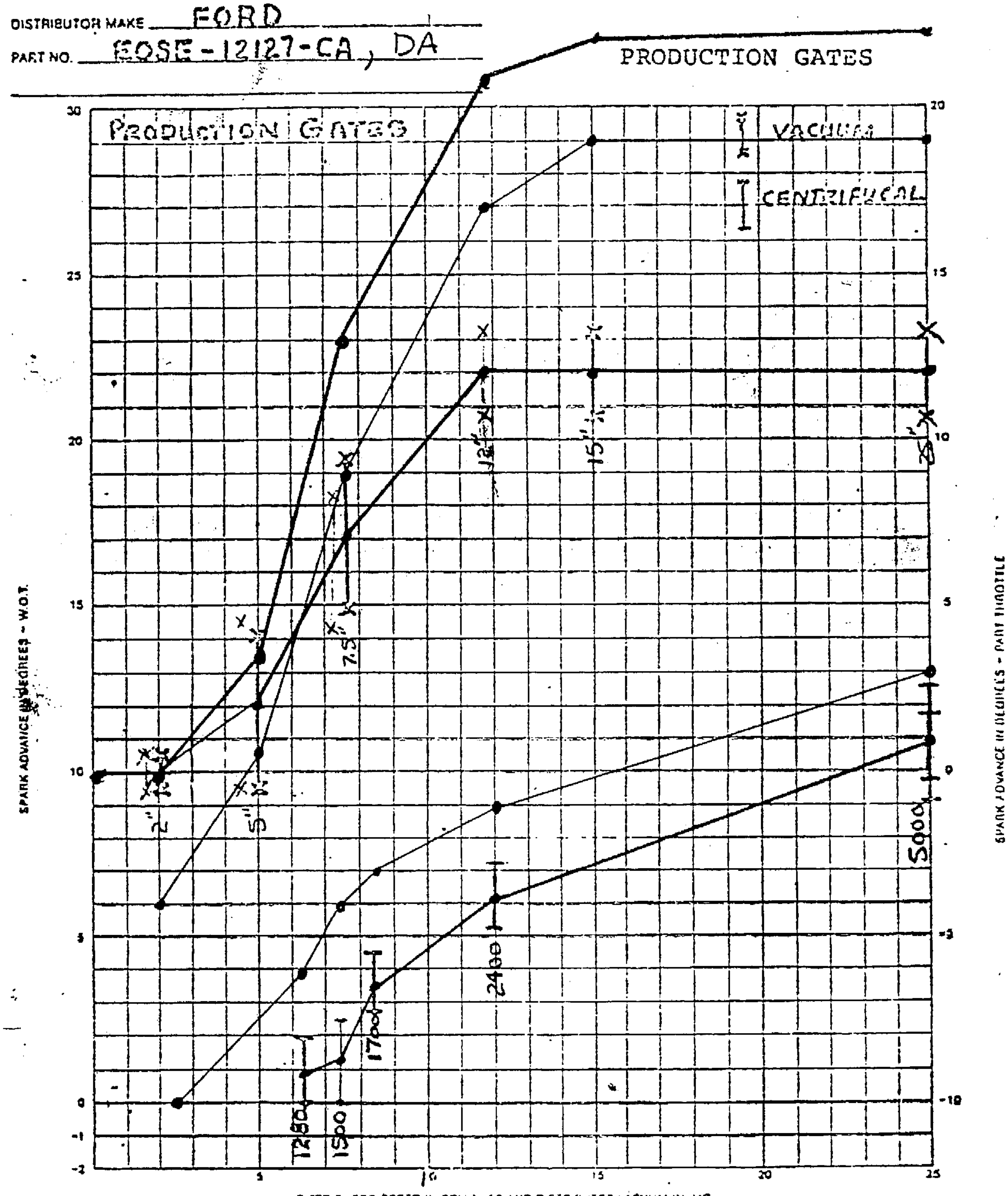
Issue Date:	JUL 29 79		10C-1	C-71	Page is ☐ Satisfactory ☐ Unsatisfactory Date EPA Rep
Revised:					

Vehicle No. 23

DISTRIBUTOR PERFORMANCE CURVE
TEST # 1 W/NEW DISTRIBUTOR
USING SUN SCOPE TIMING LIGHT

CALIBRATION SPECIFICATION
FORD MOTOR COMPANY

DISTRIBUTOR MAKE FORD
PART NO. EOSE-12127-CA, DA



Engine Family: 4.2/5.0 BJC

Issue Date:	JUN 29 79	10C-1	C-72

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Date |__|__|__| EPA Rep ______

DISTRIBUTOR PERFORMANCE CURVE

ORIGINAL STOCK DISTRIBUTOR & ADVANCE UNIT

● INDICATES TESTED ON DIST. MACH.

⊛ INDICATES TESTED IN CAR

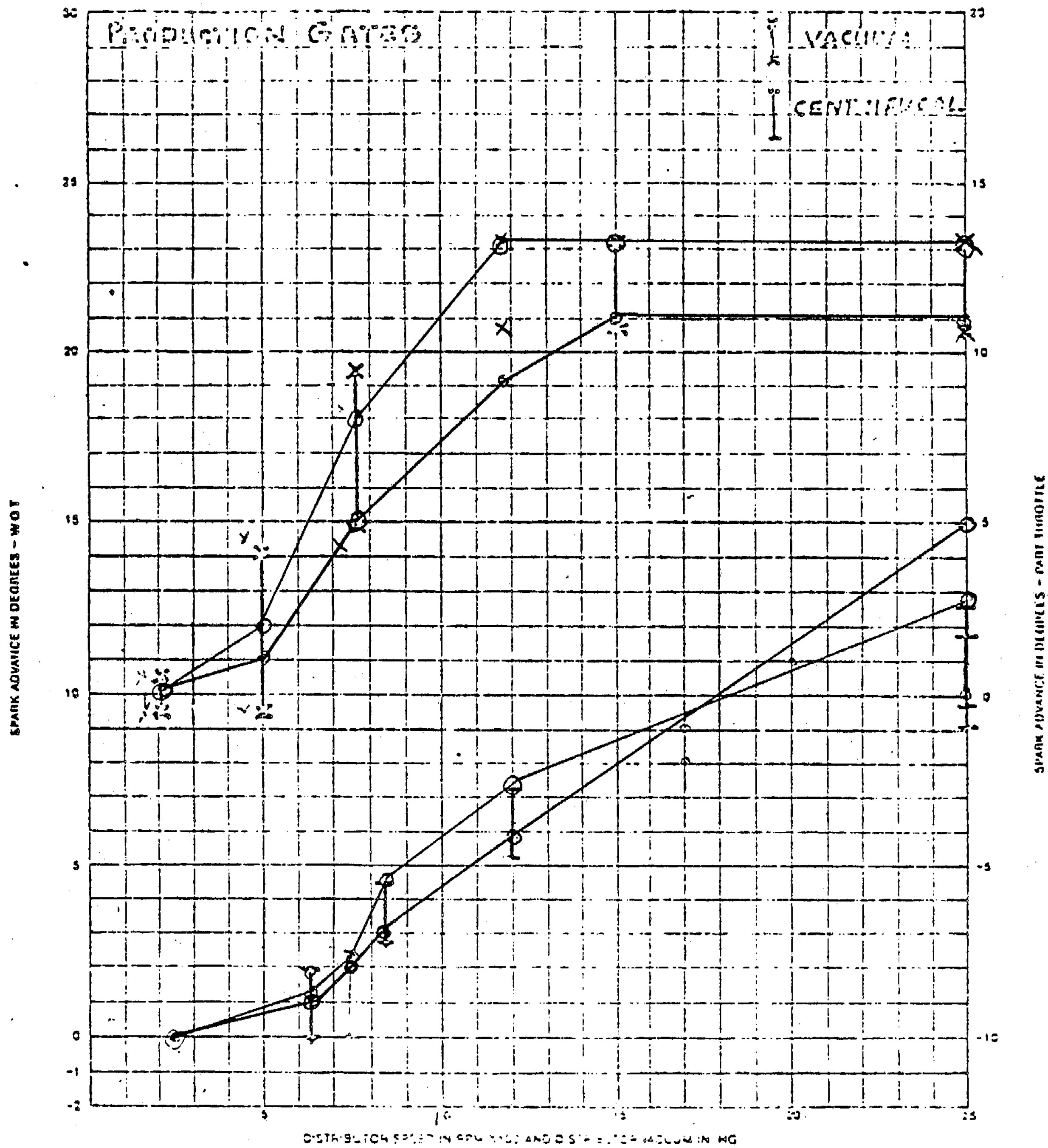
CALIBRATION SPECIFICATION
FORD MOTOR COMPANY

Vehicle No. 23

DISTRIBUTOR MAKE FORD

PART NO. EOSE-12127-CA, DA

PRODUCTION GATES



Engine Family: 4.2/5.0 BJC

10C-1

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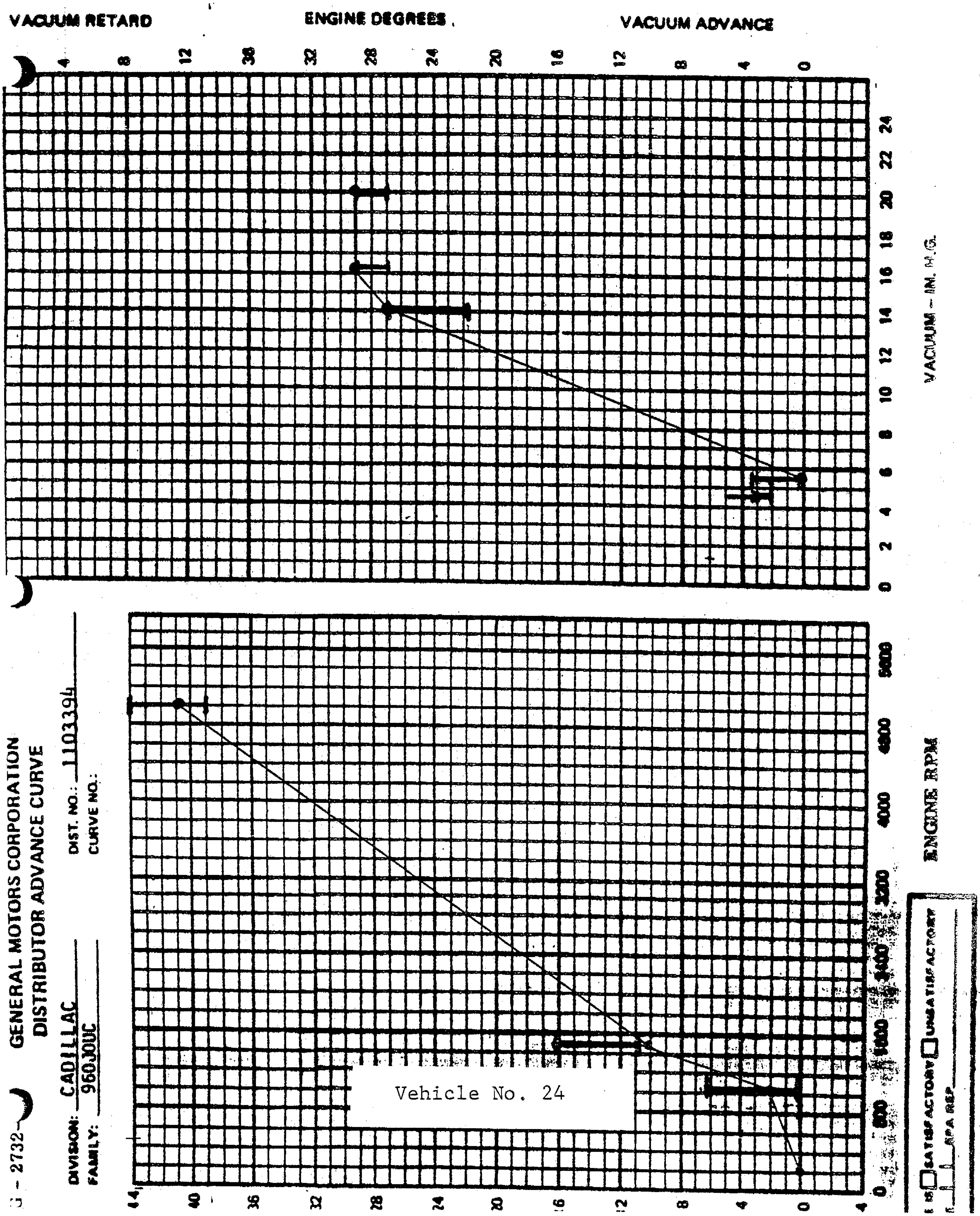
Date EPA Rep

Vehicle No. 24, 1979 Cadillac Seville - 960JOUC

ITEM	PART NO.	SPEC	ACTUAL	REMARKS
Curb Idle		600(D)RPM	600(D)	
Basic Timing		10^{o}BTDC @ 650 RPM Max	1. 2^{o} BTDC As Received 2. 3^{o}BTDC After Test	1. Reset to 10^{o}BTDC 2. Reset to 10^{o}BTDC
Spark Plugs	R475X			
Plug Gap		0.060 in.	0.060 in.	
EGR Valve	17053046			Excessive shaft wear. Replaced(P/N17052743)
Oxygen Sensor		700 to 1100 mv rich 100 to 175 mv lean	Operating range 225 mv to 750 mv	
EFI Fuel Pressure		39 PSIG $\pm$ 0.78	39 PSI @ 700 RPM	
Thermostat		178 + 4, -3^{o}F	184^{o}F	Replaced (P/N 3041388) Open at 180^{o}F
EGR Vacuum Solenoid Valve				
Activation Value		140 $\pm$ 12^{o}	138^{o} (1150 ohms)	
Deactivation Value		140 $\mp$ 12^{o}	138^{o}	
Distrib. Vacuum Solenoid Valve				
Activation Value		140 $\pm$ 12^{o}	138^{o} (1150 ohms)	
Deactivation Value		140 $\mp$ 12^{o}	138^{o}	
Distrib. Thermal Vacuum Switch				Replaced (P/N 3030975)
Activation Value		220^{o} $\pm$ 3^{o}F	Broken during removal	218^{o} F
Deactivation Value		209^{o}F Min.		210^{o}F
Economy Indicator Vacuum Switch				
Activation Value		6 in Hg	6 in. Hg	
Deactivation Value		6 in. Hg	6 in. Hg	


VACUUM RETARD
ENGINE DEGREES
VACUUM ADVANCE
VACUUM – IN. HG.
GENERAL MOTORS CORPORATION
DISTRIBUTOR ADVANCE CURVE
DIVISION: CADILLAC
FAMILY: 960JOUC
DIST. NO.: 1103394
CURVE NO.:
ENGINE RPM
Vehicle No. 24
SATISFACTORY
UNSATISFACTORY
EPA REP
G - 2732

6. If light turns on during test period, replace exhaust oxygen sensor and repeat step 2. If light remains off, system is OK; reset exhaust oxygen "sensor" indicator. Use of anti-seize compound as described in sensor replacement procedure is required.

7. If light again comes on, reinstall original exhaust oxygen sensor using a new gasket. Remove original captive gasket by cutting off with side cutters. Replacement gaskets are of the "screw-on" type. Use of anti-seize compound as described in sensor replacement procedure is required.

8. Replace ECU and repeat step 2. If light stays out, system is OK. If light comes on, recheck above steps.

TESTING ELECTRONIC FUEL INJECTION USING ANALYZER J-25400

EFI diagnosis is described in detail in a separate publication titled "Cadillac Fuel Injection Diagnosis". The procedures in the diagnosis manual require the use of Analyzer J-25400 for testing of specific components as described below.

a. Visual Inspection

The following visual inspections should be performed prior to testing.

1. Visually check all wiring harness connections for:

a. Connector not locked into position.

b. Connectors backing out of position (at ECU bulkhead connector or anywhere in wiring system).

c. Terminals not completely seated in connector housings at ECU and bulkhead connectors.

d. Improper alignment of injector connector.

e. Shorting to ground (E.F.I. wires over bracket; sandwiched wires).

f. Ground wires (including engine ground strap).

2. Visually check all vacuum lines (idle by-passage on top of throttle body may be plugged with a clean shop towel to make it easier to hear vacuum leaks):

a. To ensure all lines are securely connected to their proper fittings, Figure 6C-86 through 6C-90.

b. For broken, pinched or cracked lines.

3. Visually check fuel lines for:

a. Leakage.

b. Kinks in rubber and steel fuel lines.

c. Severely bent fuel rails.

b. Connecting Analyzer

1. Depress Analyzer Switch #1 (OFF).
2. Turn Car Ignition Switch OFF.
3. Set Parking Brake ON.
4. Set Transmission in PARK.
5. Select analyzer overlay J-25400-11 and place it on the analyzer panel retaining it in place.
6. Turn analyzer fuel pump switch OFF.
7. Connect the car harness to the analyzer as shown in Figures 6C-91 and 6C-92. This may require removal of the ECU on "C" cars.

NOTICE: Do not connect the ECU side of harness J-25400-13 to the ECU at this time as damage to the analyzer may result.

8. Connect analyzer ground lead to a good ground. **Car electrical equipment could interfere with correct operation of the EFI Analyzer. Therefore, it is important that all of this equipment is OFF during testing. This includes lights, buzzers, electric motors, etc. Doors should be kept closed to deactivate interior lighting, buzzers, and seat solenoids.**

9. Push ENRICHMENT SWITCH on extender box to ALL OTHER TESTS position.

10. POWER TO TESTER light should be ON indicating power to analyzer. If light fails to come on, check ground connection. If ground is OK check fusible link at generator BAT terminal, 10 amp in-line fuse in car harness (all except "C" car) or the 20 amp EFI fuse ("C" car only) and 5 amp fuse in analyzer extender box, Figure 6C-94.

c. Component Testing

STEP 1. CONNECT ANALYZER AS DESCRIBED ABOVE.

STEP 2. BATTERY VOLTAGE AND CALIBRATION.

a. Depress Analyzer Switch #2.

b. Analyzer POWER TO TESTER light should be on. If light fails to come on, check in line 10 amp fuse, (all except Eldorado and "C" car) or 20 amp EFI fuse (Eldorado and "C" car only) 5 amp fuse in analyzer extender box and fusible link at generator BAT terminal (all except "C" cars) for open, Figure 6C-94 through 6C-96.

c. Calibrate the analyzer by pushing the PUSH TO CALIBRATE button. With button depressed: Adjust the knob until DIGITAL METER reads 88.8. Tester is not functioning correctly if this value cannot be obtained.

d. Release Calibrate button.

e. The DIGITAL METER should read **above 11.5 volts.** (Battery voltage to ECU). If reading is **less than 11.5 volts,** check battery condition, harness 14 yellow (brown) wire and 14 orange (dark green) wires, Figure 6C-94 through 6C-96), and connections.

f. Turn Car Ignition **on.**

g. Analyzer IGNITION ON Light should be **on.** If light is **not on,** check wire between ignition switch and ECU for poor connection or open circuit (should be at least 9.5 volts), Figure 6C-94 through 6C-96.

h. Turn the car ignition switch to the START position and note the following while engine is cranking:

1. ENGINE CRANK Light should come **on.** If lamp is **not on,** inspect wire between starter solenoid and ECU for continuity, Figures 6C-94 through 6C-96.

2. The DIGITAL METER readout should not drop **below 9.0 volts** (cranking voltage). If voltage drops **below 9.0** check battery before proceeding with test (purple wire from starter solenoid should have at least 9.0 volts during cranking).

i. Return Car Ignition Switch to **off.**

STEP 3. INJECTOR GROUP 1 TEST (INJECTORS 1, 2, 7, 8)

A. Depress Analyzer Switch #3. Test each individual injector by disconnecting the other 3 injectors in the group.

1. DIGITAL METER should read **between 2.4 and 3.5** for each of the four injectors. If reading is OK, proceed to step 4.

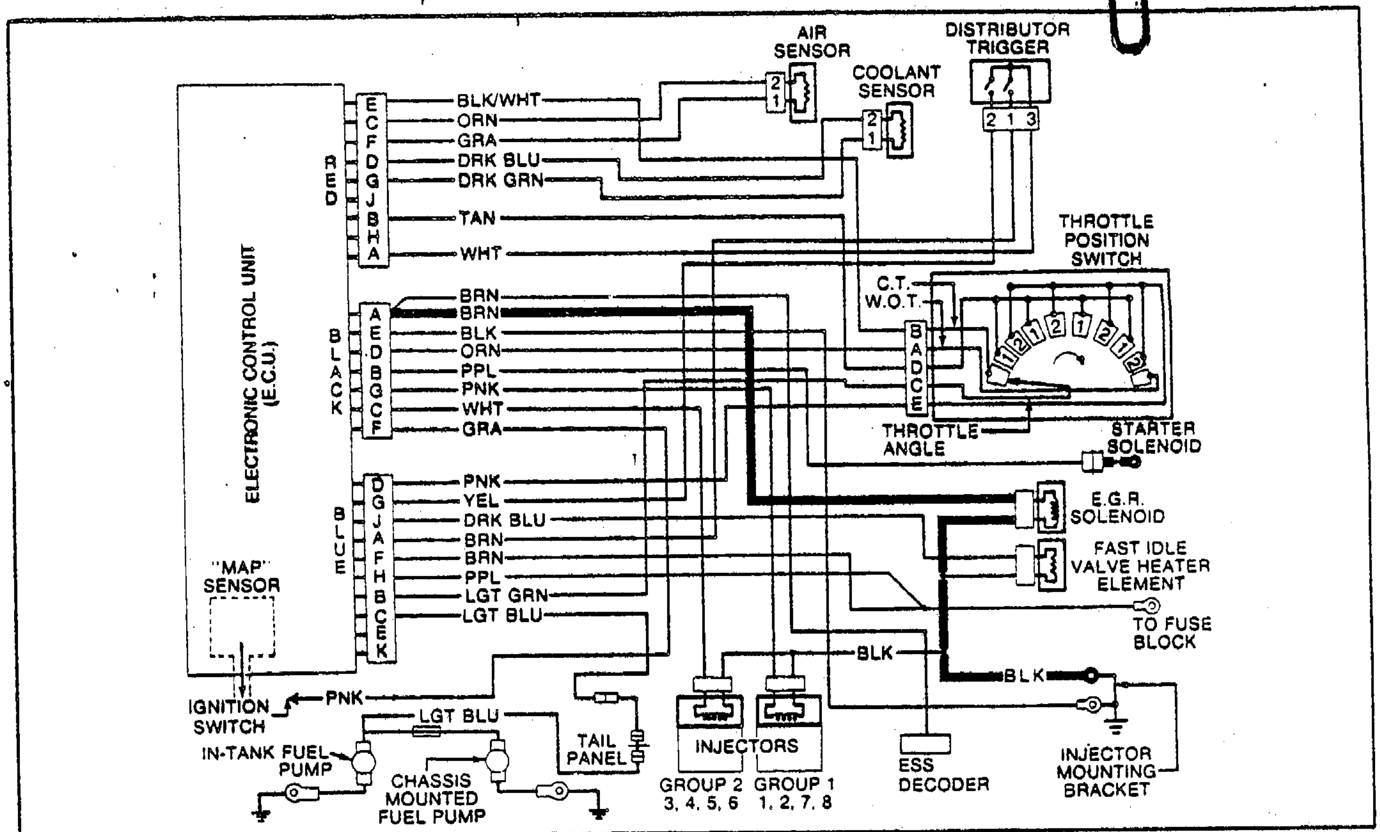


Figure 6C-108 Step 6 Circuit - Eldorado

1. If DIGITAL METER reads **less than .5**, replace Air Temperature Sensor. Retest after repair. A poor connection at the sensor connector can also cause a high resistance reading. Inspect connector before replacing sensor.

2. If DIGITAL METER reads **more than .5**, inspect orange and grey wires between sensor connector and ECU for open circuit or poor connection, Figure 6C-110 through 6C-112. Repair and retest.

C. Disconnect Wiring Harness from Air Temperature Sensor.

1. If OPEN CIRCUIT light comes **on**, replace Air Temperature Sensor. Repair and retest.

2. If OPEN CIRCUIT light remains **off**, inspect orange and grey wires between sensor connector and ECU connector for short circuit, Figure 6C-110 through 6C-112. Repair and retest.

STEP 10. COOLANT TEMPERATURE SENSOR

A. Depress Analyzer Switch #10.

1. If DIGITAL METER reads **between 600 and 1600**, and is at a reasonable resistance for prevailing temperature as shown in Figure 6C-109, proceed to Step #11.

2. If DIGITAL METER reads **more than 1600**, proceed to Part "B".

3. If DIGITAL METER reads **less than 600**, proceed to Part "C".

B. Disconnect Wiring Harness from Coolant Temperature Sensor and short the two Harness Terminals together.

1. If DIGITAL METER reads **less than .5**, replace Coolant Temperature Sensor. Retest after repair. A poor connection at the sensor connector can also cause a high resistance reading. Inspect connector before replacing sensor.

2. If DIGITAL METER reads **more than .5**, inspect dark blue and dark green wires between sensor connector and ECU for open circuit or poor connection, Figures 6C-113 through 6C-115. Repair and retest.

C. Disconnect Wiring Harness from Coolant Temperature Sensor.

1. If OPEN CIRCUIT light comes **on**, replace Coolant Temperature Sensor. Repair and retest.

2. If OPEN CIRCUIT light remains **off**, inspect dark blue and dark green wires between sensor connector and ECU connector for short circuit, Figures 6C-113 through 6C-115. Repair and retest.

STEP 11. CLOSED THROTTLE SWITCH

A. Depress Analyzer Switch #11 and observe THROTTLE SWITCH lights.

B. With throttle closed, CLOSED light should be **on** and OPEN light should be **off**.

C. If lights operate properly, proceed to Part "D".

1. If CLOSED light is **off**, check to see that throttle is closing fully (linkage, cable, floor mat, etc.).

2. Connect a jumper between black/white and light green wires at Throttle Position Switch connector, Figures 6C-116 through 6C-118.

a. If CLOSED LIGHT is now **on**:

1. Check Throttle Position Switch adjustment.

2. If adjustment is OK, or switch cannot be adjusted, replace switch.

3. Repair and retest.

Vehicle No. 24

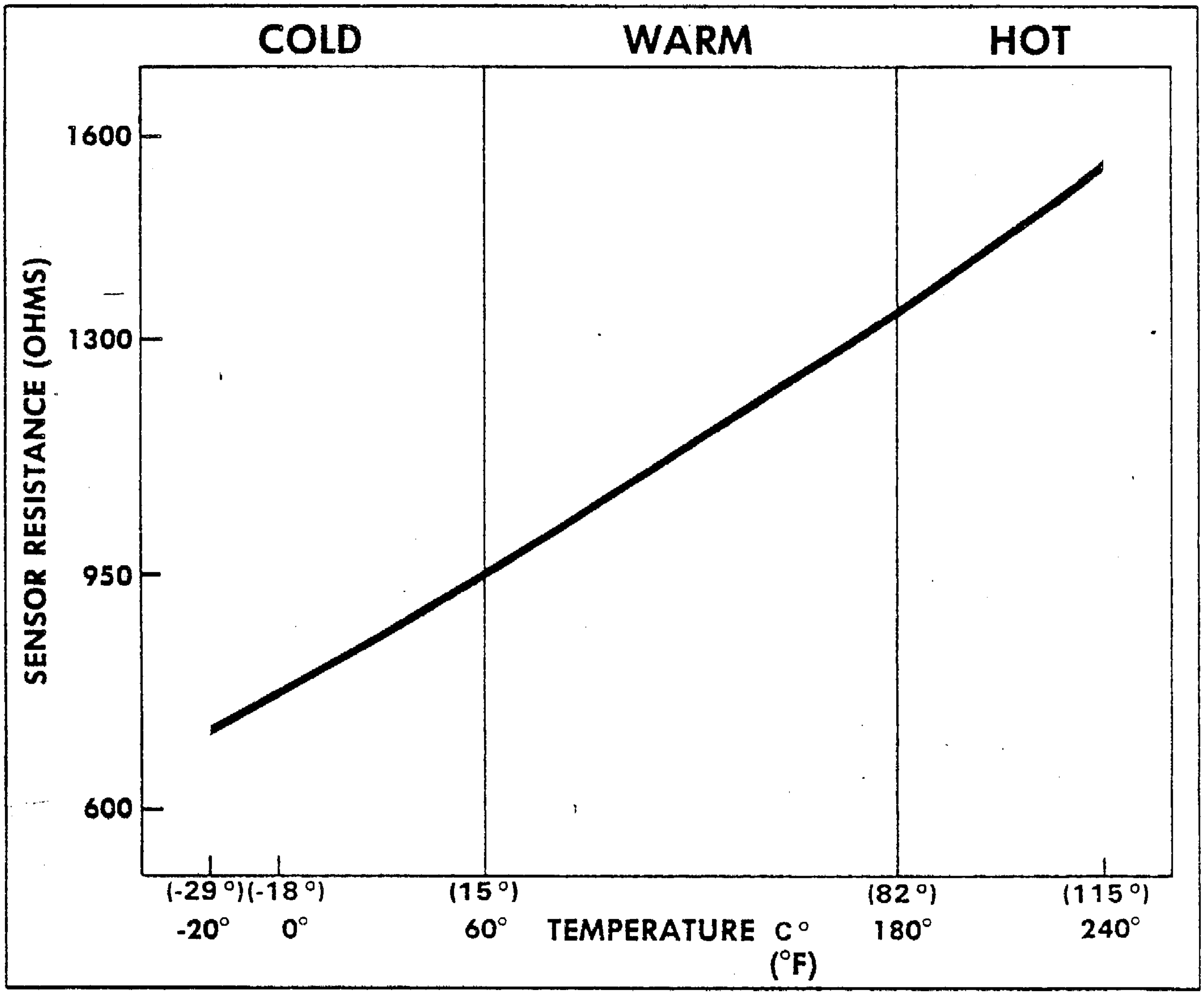


Figure 6C-109 Sensor Resistance

b. If CLOSED light did not come on:

1. Inspect black/white and light green wires between Throttle Position Switch connector and ECU for open circuit or poor connection, Figures 6C-116 through 6C-118.

2. Repair and retest.

D. Open throttle slightly and observe THROTTLE SWITCH lights.

E. CLOSED light should be **off** and OPEN light should be **on.**

1. If lights operate properly, proceed to Part "F".

2. If OPEN light remains **off:**

a. Disconnect connector at Throttle Position Switch.

b. If OPEN light comes **on:**

1. Check adjustment of Throttle Position Switch.

2. If adjustment is OK, replace switch.

3. Repair and retest.

c. If OPEN light remains **off**, inspect black/white and light green wires between Throttle Position Switch connector and ECU for short circuit, Figures 6C-116 through 6C-118. Repair and retest.

F. Slowly close throttle and observe THROTTLE SWITCH lights.

G. CLOSED light should be **on** and OPEN light should be **off.**

STEP 12. WIDE OPEN THROTTLE SWITCH

A. Depress Analyzer Switch #12 and observe THROTTLE SWITCH lights.

B. With throttle closed, CLOSED light should be **off** and OPEN light should be **on.**

1. If lights operate properly, go to Part "C".

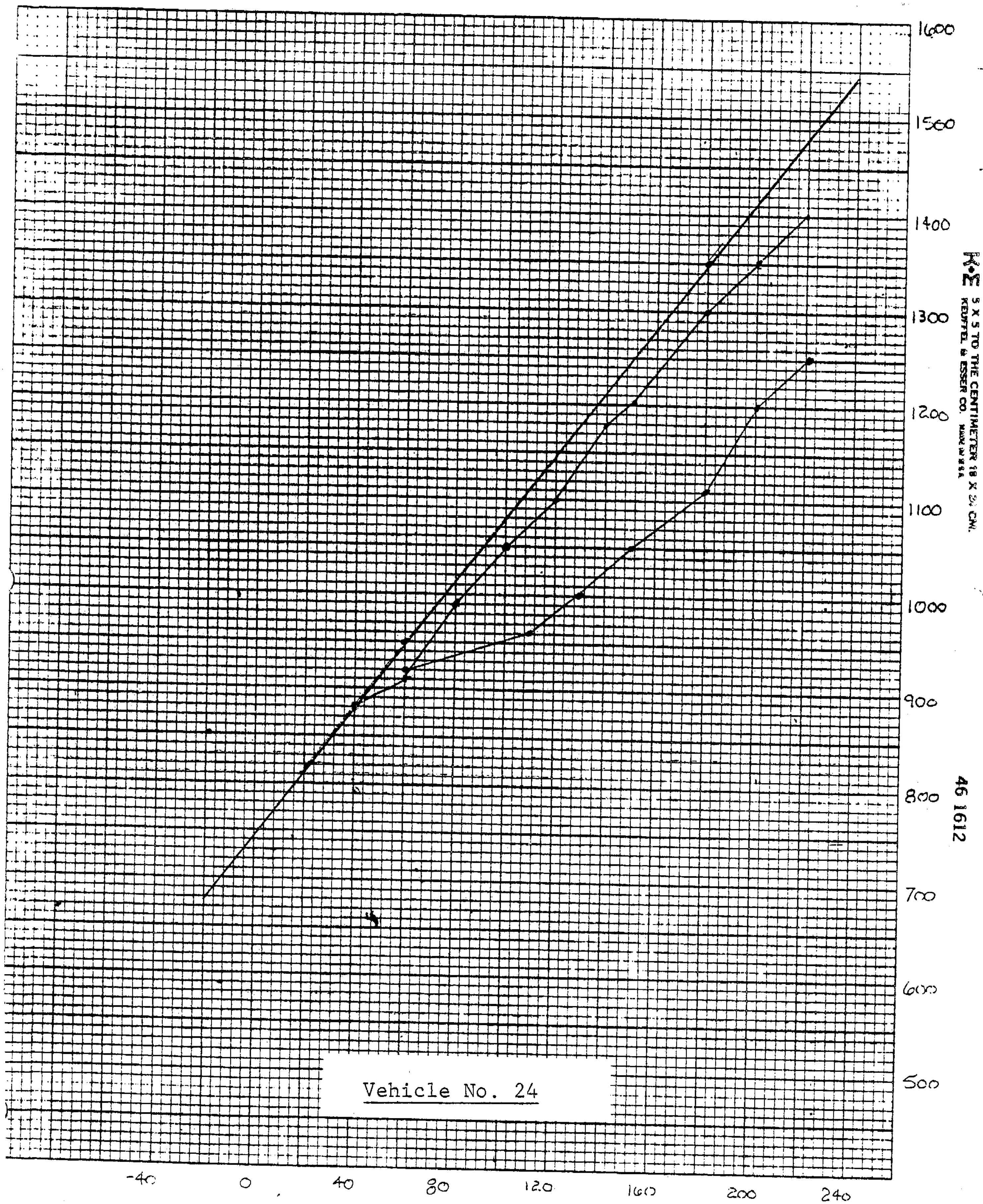
2. If CLOSED light is **on,** disconnect Throttle Position Switch connector.

a. If light **goes out,** replace Throttle Position switch. Repair and retest.

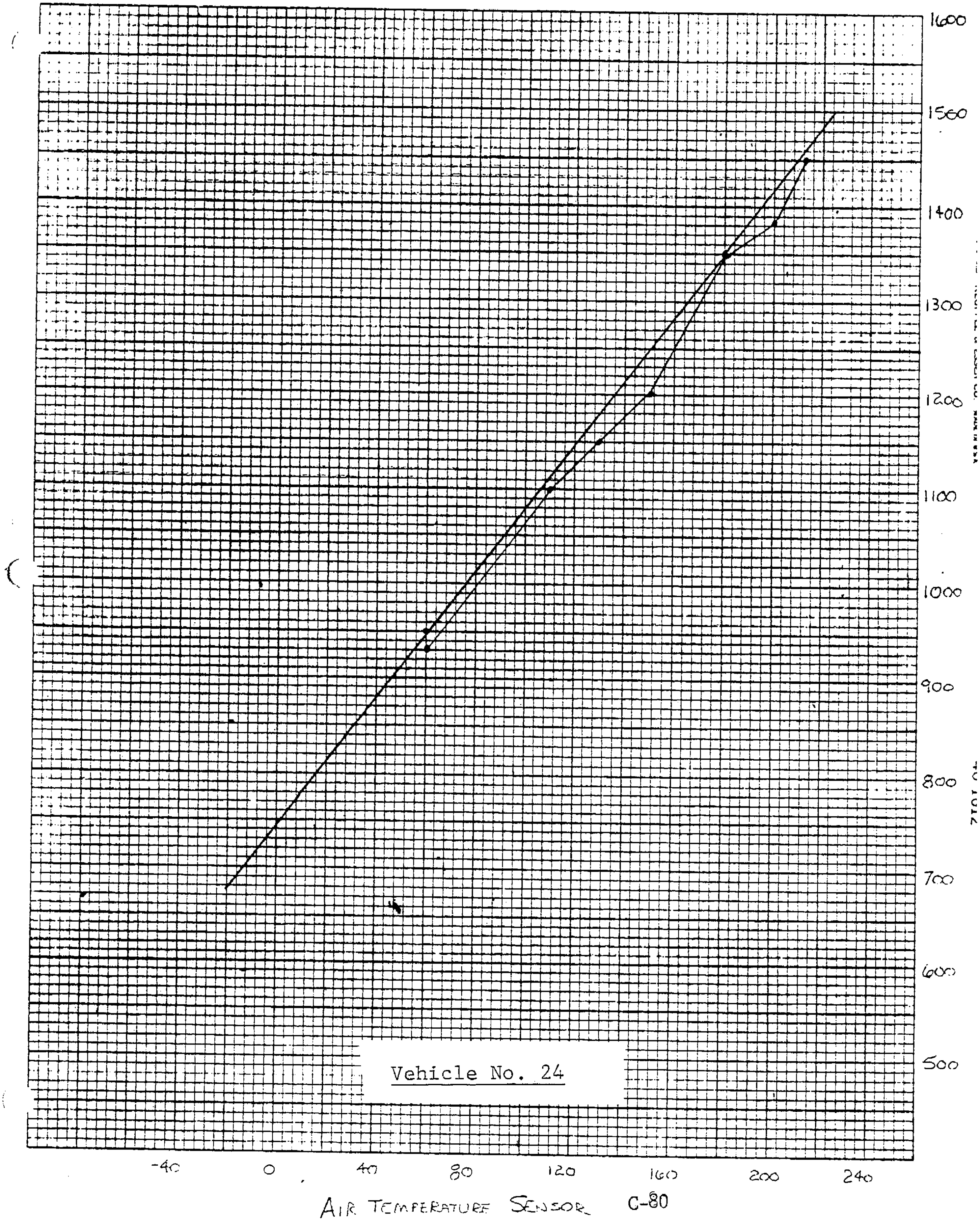
b. If light is **still on,** inspect orange and light green wires between Throttle Position Switch connector and ECU for short circuit, Figures 6C-119 through 6C-121. Repair and retest.

C. With throttle held wide open, CLOSED light should be **on** and OPEN light should be **off.**

1. If lights operate properly, proceed to Step 13.



Coolant Temperature Sensor



1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
Vehicle No. 24
-40
0
40
80
120
160
200
240
AIR TEMPERATURE SENSOR

C-80