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Application of Electronic Fuel Injection to the Optimum Engine for Methanol Utilization

RICARDO
CONSULTING ENGINEERS

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APPLICATION OF ELECTRONIC SEQUENTIAL FUEL INJECTION TO THE OPTIMUM ENGINE FOR METHANOL UTILIZATION

FINAL REPORT

Prepared for

United States Environmental Protection Agency

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SUMMARY

Ricardo Consulting Engineers have carried out a development programme to apply electronic sequential fuel injection to the optimum engine for methanol utilisation. The programme was based on a production 1.5 litre Volkswagen gasoline engine, the combustion system of which was converted to HRCC (high ratio compact chamber) with a compression ratio of 13:1. This engine had been developed to run on methanol using a carburettor and mechanically controlled ignition and EGR system prior to this program.

The electronic engine management system applied to the engine was a Ricardo Microprocessor Engine Controller (MEC) which enabled mapped control of sequential fuel injection as well as ignition timing and Exhaust Gas Recirculation (EGR) rate.

The application of sequential port fuel injection of methanol showed that the combustion process was sensitive to injection rate; sensitivity to injection timing was also shown to vary with fuel injection characteristics.

Two engine control strategies were developed, a best economy zero EGR strategy and a reduced NOx strategy using EGR and ignition retard. The characteristics of these strategies were derived from the observed response of the engine on the testbed to mixture distribution, EGR and ignition retard. Modelling of a number of possible control strategies showed that a revised fuelling strategy wide range of HC and NOx emissions was possible. However, it was evident that control strategies for reduced HC emissions could result in large increases of NOx emission. The best economy strategy was based on a lean part load mixture strategy having a typical equivalence ratio of 0.7 with optimum ignition timing. The reduced NOx strategy used richer mixtures, EGR and ignition retard to strike a balance between NOx reduction, HC increase and fuel consumption penalty. Simulation over the LA4 drive cycle for an Audi 5000 vehicle predicted the following results:-

	HC	NOx g/mile	CO	Methanol Fuel Cons. miles/US gallon
Best economy strategy	1.92	1.75	3.37	16.3
Reduced NOx strategy	1.82	.67	14.52	15.4

Initial optimisation of transient and warm-up strategies were carried out on the testbed but it was recognised that further development would be required to refine driveability with the engine installed in the vehicle. The mechanical condition of the engine and fuel handling system remained satisfactory throughout the test programme.

Recommendations for further work were made.

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1. INTRODUCTION

In the future supplies of conventional, petroleum based, fuels for road vehicles are likely to be less readily available and probably more expensive than at present. The potential for many alternative energy sources to supplement or, in some vehicle applications, to entirely replace conventional fuels has been evaluated by numerous investigators and the relative merits of many of the possible alternative fuels are now quite well understood. Methanol has various characteristics which are desirable attributes of future alternative fuels - it can be produced from a variety of raw materials (some of which are renewable), production technology already exists, the fuel is in liquid form which facilitates storage, transportation and handling and its energy density is moderately high which therefore provides an adequate vehicle range for a quite modest weight of fuel.

Of the properties of methanol which specifically relate to its suitability as a fuel for conventional light duty engines, its poor self ignition characteristics - low cetane number - ensures that it is not easily utilised in diesel engines. Conversely, its high octane quality implies fairly ready application in spark ignited engines. The octane number of methanol is significantly higher than that of current motor gasoline so that it lends itself for use in engines having relatively high compression ratios with inherent thermal efficiency advantages over current gasoline engines. Methanol also has good lean burn properties, so offering further advantages in terms of thermal efficiency and low exhaust emissions when employed in a spark ignited engine.

In recent years several research organisations have worked on the development of engine concepts capable of successfully utilising high compression ratios. The Ricardo HRCC (high compression ratio, compact combustion chamber) engine is one example of this approach which, by careful design of the combustion chamber permits the use of a high compression ratio (with a relatively low fuel octane requirement) together with an ability to successfully utilise lean mixtures or tolerate high levels of EGR. Both are important attributes with regard to fuel economy and exhaust emissions.

Considerations of the major performance characteristics of the HRCC combustion system and some of the properties of methanol fuel suggested that they compliment each other to a large extent. It therefore appeared that an HRCC unit was a promising basis for the development of an optimum engine for methanol utilisation. In order to confirm this theory a practical engine test programme aimed at investigating the potential performance, fuel economy and exhaust emissions of an HRCC engine when fuelled with methanol was carried out by Ricardo on behalf of EPA (1). This resulted in the production of a methanol fuelled, high compression ratio, compact chamber (HRCC) engine in which air/fuel mixture strength was controlled using a simple carburettor and ignition timing was varied using a conventional distributor with vacuum advance. This engine showed considerable potential with regard to high thermal efficiency and low exhaust emissions; however, it was apparent that the relatively simple engine control system used, imposed significant limitations on several aspects of engine performance. The aim of the current project, as defined in Contract No. 68-03-1968 was the application of an electronic sequential fuel injection system to the engine to replace the carburettor. The quantity of fuel delivered, together with the other control parameters of ignition timing and EGR rate, were also to be controlled by the electronic management system. With this arrangement various possible engine control strategies, capable of maintaining low exhaust emission levels and providing high thermal efficiency were to be investigated. This report describes the experimental techniques used and the engine management system utilised for this particular programme.

The installation of the engine in and subsequent testing of an Audi 5000 vehicle were to be carried out by EPA.

2. THE HRCC ENGINE

2.1 General

The Ricardo HRCC gasoline combustion system has been the subject of considerable research and development work over a number of years (2-6). This work culminated in the derivation of general guidelines for the design of combustion chambers capable of operating at compression ratios of 1 to 2.5 numbers higher than conventional combustion chambers, when using fuel of equal octane quality, resulting in economic improvements of the order of 5%. The HRCC arrangement was also found to permit utilisation of leaner air/fuel mixtures than was possible with conventional combustion chambers while still maintaining an adequate safety margin from the misfire limit and consequent vehicle driveability problems; this yielded further fuel economy improvements, making a total of the order of 10%. Furthermore it was found that increases in brake mean effective pressure (BMEP) of 5-10% over much of the engine's speed range were generally achieved with HRCC combustion systems.

The ability of HRCC engines to operate well with lean air/fuel mixtures ensured that NOx and CO emissions were relatively low. HC emissions were somewhat increased over those produced by well developed conventional

* Numbers in parentheses indicate reference numbers in Section 9.0

combustion chambers operating at a lower compression ratio but were nevertheless maintained at a reasonable level.

Most of the initial HRCC investigations were carried out using single cylinder research engines. Later the experience gained with the single cylinder units was applied in a Ricardo research exercise to the design of an HRCC version of a production 1.5L, four cylinder, Volkswagen engine. After a short development programme this engine was installed in a passenger car in which application it exhibited good performance, fuel economy and exhaust emission characteristics when operating on 97 RON gasoline (7).

As a basis for the development of an optimum engine for methanol utilisation a unit identical to the original HRCC version of the 1.5L Volkswagen engine used in Ricardo's research work was employed (See Figures 1,2 and 3).

2.2 Engine Characteristics

The particular engine to be used for this work had been developed during a previous exercise (1) in the form of a carburetted methanol fuelled HRCC engine. Most of the main components including cylinder block, crankshaft, oil pan, exhaust manifold, oil and coolant pumps were production Volkswagen parts. Some components were particular to the HRCC combustion system, i.e. cylinder head assembly and pistons. Other special components were mandated because of the use of methanol fuel; carburettor, intake manifold, intake heating element. A high energy, Delco-Remy, ignition system was incorporated in order to improve the engine's lean operating capability.

For the present exercise the main components of the engine were retained but the use of sequential fuel injection and an electronic management system dictated that some new parts were required. These are outlined in Sections 2.6 and 2.7

2.3 Basic Engine Specification

Configuration	4 cylinder, in-line
Bore diameter	79.5mm
Stroke	73.4mm
Displacement	1.457 litres
Compression ratio	13:1 nominal
Cylinder block	cast iron with integral cylinder bores
Cylinder head	aluminium with uni-sided inlet and exhaust ports.
Combustion chambers	HRCC type in cylinder head under exhaust valve. 1 inlet and 1 exhaust per cylinder. Single spark plug.
Valve gear	Direct attack with an overhead camshaft.
Inlet valve inner seat dia.	30.5mm

Exhaust valve inner seat dia.	29.5mm
Inlet valve opens	8° BTDC
closes	52° ABDC
max. lift	9.3mm
Exhaust valve opens	52° BBDC
closes	8° ATDC
max. lift	9.3mm
Fuel system	multipoint sequential injection (See section 2.6)
Ignition system	Bosch Transistorised Ignition
Spark plugs	Champion BN60Y
Engine management system	Ricardo MEC (See section 2.7)

2.4 Inlet System

In order to accommodate the fuel injection system, the carburettor and intake manifold assembly used during earlier work on the engine were replaced by the components listed below. In addition, existing bosses on the cylinder head were machined to permit attachment of the fuel injectors; machining was also carried out to provide for location of an inlet charge temperature sensor in the inlet port downstream of the fuel injector.

1 x intake manifold	Volkswagen Part No. 067 133 201L
1 x throttle body assembly	Volkswagen Part No. 067 133 063K
1 x rubber elbow	Volkswagen Part No. 067 133 357
1 x Air filter assembly	Volkswagen Part No. 067 133 837F
1 x Air cleaner top	Ricardo Part No. 3355-38
1 x Throttle bypass valve	Bosch Part No. 0 280 140 107

2.5 Exhaust System

A Volkswagen Passat vehicle exhaust system was used being modified to incorporate an un-catalysed ceramic monolith. This ensured exhaust back pressures similar to those likely to be encountered in a US model vehicle with an exhaust catalyst fitted.

2.6 Fuel System

Fuel was delivered from the tank, via a filter, to a fuel rail by a pump. The pressure in the fuel rail was maintained at 2.6 bar by a regulating valve. Excess fuel was routed from the valve back to the tank. Solenoid operated injectors were sealed to the fuel rail by suitable 'O' rings.

The fuel pump was primarily intended for use with gasoline and was likely to require periodic replacement when handling 100% methanol. The suppliers (Bosch) recommend replacement after 100 hours.

The fuel filter was a special component designed to be entirely compatible with methanol fuel and was supplied by Bosch.

Gates GP80 was used for all flexible pipework. The fuel rail was fabricated from stainless steel and should therefore be unaffected by methanol.

A standard production, gasoline, pressure regulator was used. The suppliers (Bosch) claimed that this component would operate satisfactorily with methanol.

The fuel injectors specified were special methanol proof units having the necessarily high flow rate capacity.

The fuel system comprised the following main components:-

1 x Fuel Pump	- Bosch Part No.	- B580 112 498
1 x Fuel Filter	- Bosch Part No.	- B450 024 182
1 x Fuel Rail	- Ricardo Part No.	- 3355-39
1 x Pressure Regulator	- Bosch Part No.	- 0-280-160-200
4 x Fuel Injectors	- Bosch Part No.	- B280-412-372/2 U-895
1 x Location Plate-Injectors	- Ricardo Part No.	- 3355-40

2.7 Engine Management System

A Ricardo microprocessor engine controller (MEC) was used to control fuelling, ignition timing and EGR rate. The MEC unit input signals were provided by the following sensors:

Throttle movement	AC Delco Part No. P36-D70603
Engine Speed/Crank Position	Orbit Controls Part No. 80D1102
Cam Position/Cylinder Phasing	Radio Spares 308-578
Manifold Absolute pressure	Bofors Electronics - PT-310JA
Charge Temperature	Universal Thermosensors T15-DKN-310-YP-600
Coolant Temperature	Platinum resistance thermometer Type PRT 100 No. P445001
Ambient Temperature	Platinum resistance thermometer Type PRT 100 No. P445001

The general principles of operation of the engine management system are outlined in Appendix 1.

The ignition system comprised of the following production components:

Coil	- Bosch Part No.	- 1-220-522-011
Ignition Module	- Bosch Part No.	- 1-227-022-008

2.8 EGR System

The purpose of the EGR system was to re-circulate modulated quantities of exhaust gas to the engine air intake. The presence of this largely inert exhaust gas in the working charge of the engine serves to lower peak combustion temperatures and so reduce the formation of NOx. Excessive quantities of EGR can cause an increase in HC emissions and fuel consumption. It was therefore important that EGR rate be accurately controlled over the operating range of the engine.

The EGR system used for this work is shown in Figure 4. The basic EGR circuit was conventional, comprising 10mm bore pipework and a vacuum operated control valve. The vacuum applied to the EGR valve was modulated by an electro-pneumatic transmitter. This transmitter was electrically connected to a control unit which received a voltage signal proportional to the required extent of opening of the EGR valve from the MEC and a signal from a linear position sensor fitted to the EGR valve spindle indicated actual valve opening. The control unit adjusted the vacuum signal produced by the electro-pneumatic transmitter so that actual opening of the EGR valve equalled that required by MEC.

EGR control valve	-	Pierburg Part No. T4KR.7.114
Electro-pneumatic transmitter	-	Pierburg Part No. 7.21.031.00
Control unit	-	Pierburg Part No. PV12.300

The definition of the Design Specification of the EGR System was reported in (8).

3. CHARACTERISTICS OF METHANOL FUEL

Several of the properties of methanol are particularly noteworthy regarding its use as a fuel for spark ignited engines. These are summarised in the paragraphs below.

It has a high knock resistance; several different values of RON and MON are quoted in the literature, the variation being mainly due to the difficulties involved in applying a test procedure developed for use with relatively low octane, wide boiling range, gasolines to high octane, single boiling point, methanol which has a high latent heat of vaporisation. The high knock resistance favours the use of high compression ratios.

A very significant adverse property of methanol, which affects its use in engines, is its strong tendency to pre-ignite (9). Many earlier investigations of methanol utilisation have encountered this problem. It can be alleviated by attention to cooling of combustion chambers and by employing an appropriate grade of spark plug, but has been found to be a troublesome feature in some engine application exercises.

The calorific value on a weight basis of methanol is only 45% of that of gasoline hence a considerably higher fuel flow is required at any given engine operating condition. This implies the need for changes in the fuel metering system when changing from gasoline to methanol operation.

The density of methanol is higher than that of gasoline hence fuel consumption on a volumetric basis is not as high as might be anticipated by consideration of its calorific value only.

The high boiling point of methanol together with its high latent heat of vaporisation are responsible for the poor cold starting characteristics often associated with engines using this fuel. The most popular means of overcoming this problem, cited in the literature, is by using either a fuel additive which has a low boiling point, e.g. isopentane (10), or a supplementary fuel, such as conventional gasoline, which is used only for starting (11). Both of these approaches involve significant inconvenience and/or complexity. A more desirable approach is the use of supplementary heat applied to the ingoing charge which may assist charge vaporisation and obviate the formation of ice in the intake system during conditions of high ambient humidity.

It is well established that methanol has generally a wider mixture strength combustion limit than gasoline. This is largely due to the higher flame speeds which occur in methanol/air mixtures (12).

Combustion temperatures of methanol/air mixtures are significantly lower than those occurring in gasoline/air mixtures even when initial mixture temperatures are equal (13). In practice the high latent heat of vaporisation of methanol ensures that the temperature after compression of a methanol/air mixture is considerably lower than that of an equivalent gasoline/air mixture. Lower combustion temperatures favour lower heat losses, hence producing higher thermal efficiency, and also inhibiting the production of NOx during the combustion process.

Combustion of methanol produces a greater number of moles of combustion products than is the case with gasoline. The combustion equations for stoichiometric air/fuel mixtures of the fuels are as follows:

For a typical gasoline -

$$CH_{1.8} + 1.45\,(O_2 + 3.77\,N_2) \quad CO_2 + 0.9\,H_2O + 1.45\,(3.77\,N_2)$$

i.e. for every 6.92 moles of air consumed 7.37 moles of products are formed, a ratio of 1.065.

For methanol:

$$CH_4O + 1.5\,(O_2 + 3.77\,N_2) \quad CO_2 + 2H_2O + 1.5\,(3.77\,N_2)$$

i.e. for every 7.16 moles of air consumed 8.66 moles of product are formed, a ratio of 1.209.

The greater number of moles of product from methanol combustion favours the production of a higher pressure in the cylinder, hence a greater engine power output and the attainment of a higher thermal efficiency.

Methanol can chemically attack some of the materials commonly used in engine fuel systems, notably the magnesium alloys often used in carburettors. Such corrosion is a particular problem when water is also present. Some polymers often used as sealing materials may also suffer chemical degradation or be liable to swelling when in contact with methanol.

4. TEST EQUIPMENT

4.1 Test Bed Installation and Instrumentation

The engine was installed on a testbed and coupled to a Schenck W70 eddy current type dynamometer. Instrumentation was provided for the control and monitoring of lubricating oil and cooling water temperatures; these were regulated to 80^{o} C for oil inlet/water outlet. Inlet air temperature was measured at the throttle inlet and exhaust gas temperature was measured at a point about 100mm downstream of the junction of the twin downpipes and 950mm downstream of the exhaust valve. An exhaust gas sample probe was fitted at the same location. Inlet manifold and exhaust back pressure were determined using a Druck pressure transducer. Fuel mass flow was calculated using data from a calibrated volumetric burette, stopwatch and thermometer. The ignition timing, fuelling and EGR rate were changed and monitored by the Ricardo microprocessor engine controller. (See Appendix II).

Samples of exhaust gas were analysed using a Ricardo emissions trolley with the following analysers:

CO, CO_2, Inlet CO_2	- Analytical Developments NDIR
NOx	- Thermoelectron Corp. Model 10 chemiluminescent analyser.
HC	- Ratfisch RS5 FID fitted with a separate, heated (120^{o}C) sample line.
O_2	- Servomex paramagnetic type OA250

All HC measurements were converted to a base of ppm carbon before calculation of brake specific HC emissions.

The FID analyser was calibrated using propane following normal Ricardo practice and no special allowance was made during the test programme for the fact that methanol is an oxygenated HC species fuel. (No legislation currently exists to differentiate between gasoline and methanol HC measurement methods). The measurements made using an FID instrument are not mass related, the ionisation indicated depends on the property of the particular HC species being assessed. Oxygenated HC species result in a different FID sensitivity and current practice is expected to under estimate total HC emission by 20-30%.

A Lambdascan instrument was used to give an instantaneous air/fuel ratio trace during the transient and cold start tests by analysis of the exhaust emissions. This instrument has a response time of about 300 msec and is therefore sensitive to rapid changes in mixture strength.

4.2 Test Fuel

All testwork was carried out using methanol fuel. The specification and other relevant data used during this programme is shown in Table 1.

4.3 Data Processing

Raw testbed data was processed utilising the Ricardo 'in-house' computer progam EMS. This used formulae taken from the EPA Federal Register Volume 42 No. 174 dated 8th September 1977. This provided correction of full load performance measurements to 20°C and 760 mmHg using the method described in (14). Brake specific fuel consumption and exhaust emissions were also calculated. BSNOx results were corrected to 75 grains/lb humidity using the EPA correction formula. In order to facilitate comparison of brake specific fuel consumption, when methanol fuelled this was converted to brake thermal efficiency by using the calorific value of the fuel noted in Table 1.

Mixture strength air/fuel ratio, and hence equivalence ratio, was calculated from emissions data using a method derived by Brettschneider (15).

$$\text{Equivalence ratio defined as:-} \quad \frac{\text{stoichiometric air/fuel ratio}}{\text{actual air/fuel ratio}}$$

was used when considering results of dilution tolerance tests.

Volumetric efficiency and brake specific air consumption were determined from measured fuel flows and the calculated air/fuel ratios.

EGR rate was defined as the flow rate of recycled exhaust gas divided by the total flow rate into the engine and was calculated as follows:-

$$\% \text{ EGR} = \frac{\text{Inlet } CO_2 \text{ with EGR} - \text{Inlet } CO_2 \text{ without EGR}}{\text{Exhaust } CO_2 \text{ with EGR}} \times 100$$

4.4 Reduced NOx Strategy Optimisation

A Ricardo computer program "CONTROL" was used to analyse testbed engine data on fuel consumption and emissions to enable examination of the trade-off between exhaust emissions levels and fuel consumption. The programme also calculates the most fuel efficient equivalence ratio and EGR strategy to comply with specified sets of emission limits using a simple 'keypoint' drive cycle model. This model can thus identify fuel efficient strategies for emission reduction to aid initial control strategy development.

The use of this program is based on a simple cycle simulation which represents the LA4 drive cycle using keypoint operating conditions. Also required is the response of emissions and fuel consumption for each of these keypoint equivalence ratio conditions of equivalence ratio and EGR values. Program output is calculated for the LA4 Urban driving cycle.

Using the engine response characteristics the program is able to derive control strategies for a range of exhaust emissions each of which is a best economy solution. In other words for each level of predicted exhaust emissions the control strategy identified is the optimum solution.

However not all strategies are necessarily practical and engineering judgement may therefore be required to implement a particular strategy to an engine.

4.5 Vehicle Simulation Work

Since the ultimate objective of the project was to produce a methanol fuelled engine capable of providing good vehicle performance it was considered important to assess the likely fuel economy and exhaust emissions of a vehicle fitted with the engine. In order to provide approximate predictions of these characteristics a Ricardo computer simulation program (16) was employed.

The computer program used (CYSIM) is primarily designed to predict the levels of exhaust emissions and fuel consumption to be expected from a vehicle during operation over a prescribed velocity cycle (in this case the 1975 FTP). Vehicle performance, in terms of acceleration times, can also be predicted.

Essentially the program analyses the driving cycle and, from a knowledge of vehicle characteristics, calculates the engine speed and BMEP required to drive the vehicle over each velocity increment in turn. Knowing these two parameters the levels of exhaust emissions and fuel consumption are extracted from engine test bed performance maps which are represented in the program input data by two dimensional numerical arrays.

The emissions data used as input to the simulation program and hence the predicted results produced by it refer to `engine-out' exhaust conditions. The effects of any exhaust after treatment system, such as the oxidation catalyst to be fitted by EPA for the vehicle application tests, is not accounted for.

It should be emphasised that the predicted results produced by the simulation program are very approximate due to the use of several simplifying assumptions which are incorporated in the program in order to facilitate its use. The principal sources of errors are:-

i) The computer program produces simulated results of transient tests using engine performance and emissions data derived under steady state conditions, it is likely that under true transient operation engine performance and emissions levels will show some variation from predicted results.

ii) All engine data used as input is nominally acquired at normal operating temperatures. In actual 1975 FTP tests, the engine starts from cold and hence its performance and emissions during the early part of the test may be considerably different to what is predicted.

iii) Engine testbed data is normally not available under conditions such as motoring or in the transition area between positive and negative BMEP. Combustion under these conditions can result in high levels of HC emissions

(These three points have been confirmed in previous work in which simulation results were compared with measured data when some divergence, especially in the case of HC emissions, has been observed).

It has been observed in previous exercises that the computer predicted values of HC and CO emissions were generally lower than those observed during actual vehicle tests, primarily due to the fact that the effects of cold start mixture enrichment and the enrichment normally occurring during transient manoeuvres in a real vehicle installation are ignored in the simulation program. Similarly NOx emissions can be expected to be reduced.

For the vehicle simulation exercises the engine was assumed to be installed in a Audi 5000 passenger car. The main characteristics of this vehicle were taken as:-

Inertia weight	1477 Kg (3250 lb)				
Mass weight	1318 Kg (2900 lb)				
Transmission	manual, 5 speed				
Ratios	1 3.6	2 1.94	3 1.23	4 0.86	5 0.68
Final Drive Ratio	4.78				
Tyre rolling radius	0.3m				

Polar movement of inertia of:

engine and gearbox	0.18 $Kg.m^2$
driving wheels	1.3 $Kg.m^2$

5. ENGINE DEVELOPMENT

The engine was received from EPA in carburetted form. Before installation on the test bed the engine was stripped down, inspected, modified and re-assembled in fuel injected form. Inspection of the engine component parts showed that these were in satisfactory condition.

Once installed on the testbed, the engine was run-in for a period of 8 hours to ensure that it had "bedded in" after the rebuild. The calibration and operation of the instrumentation was checked before testwork commenced.

5.1 Comparison of A.C. Delco and Bosch/M.E.C. Ignition Systems

The engine was initially installed with the A.C. Delco ignition system as received form EPA. This was to enable a comparison to be made with the Bosch electronic ignition unit with which the MEC system is compatible. Two part-load mixture loops each having different speed and load values were carried out the results of which are presented in figures 5 to 12. The test data at both engine conditions shows that the performance with each ignition system results in very similar levels of thermal efficiency and exhaust emissions for a particular equivalence ratio. The results also indicate that the dilution tolerance is unchanged between systems although there is a trend for the Bosch ignition to result in a lower level of HC emissions. Ignition timing for MBT was also similar with the exception of lean operation at the higher speed and load condition where the Bosch unit resulted in a reduced MBT value.

The conclusion drawn from these tests was that the Bosch system results in similar ignition performance characteristics and was therefore suitable for the project. All further engine test work was carried out using the Bosch unit.

5.2 Engine Performance Comparison between Correct and Incorrect Injectors

Soon after testwork started in March 1985 it became apparent that the injectors supplied by Bosch were not able to deliver sufficient fuel for a full load power curve over the engine speed range. The fuelling rate could not be maintained above 60 rev and the throttle had to be progressively closed to maintain a safe air fuel ratio.

While Ricardo made repeated efforts to obtain a set of correct specification injectors from Bosch it was decided to continue with the part-load testwork so that some reference data could be established for comparison with correct injectors.

The effects of mixture strength, ignition timing and injection timing on engine performance were to be investigated as appropriate, at 7 key point load/speed conditions. These were taken from Appendix I of Ricardo report (17) and are reproduced below:-

Speed (rev/sec)	Load BMEP (bar)
15	0 (idle)
40	1.5
40	2.5
40	5.5
60	2.5
60	5.5
60	7.0

These key points (illustrated in figure 13) were derived from the Ricardo vehicle drive cycle simulation program, CYSIM, as those key point engine speed/load conditions during which the most significant proportions of total fuel consumption and exhaust emissions occur.

5.2.1 Full Load Performance

The full load performance comparison is shown in figures 14 - 17. Whilst it is clear that correct injectors enable full load operation over the speed range the low speed performance is noticeably reduced. This is because of a change of volumetric efficency which may be attributed to the change of fuel injection rate. The lower rate injectors would have a greater potential for charge air cooling because the fuel air mixing times are approximately doubled. This trend is confirmed throughout the part load test results, particularly at higher power levels, when reduced manifold air pressure is accompanied by long injection periods.

5.2.2 Injection Phasing

A comparison of injector phasing sensitivity is shown in figure 18. For this test the end of injection (E.O.I.) was set at 18 points equispaced around the 720^{o} cycle, performance and emissions readings being taken at each point. It can be seen that the HC emission results obtained with the incorrect injectors show a marked increase from 180^{o} BTDCNF to 180^{o} ATDCNF which is probably due in part to injecting whilst the inlet valve is open, allowing for a proportion of the fuel to pass directly into the exhaust system.

The results obtained with the correct injectors show that HC emissions do not exhibit the same sensitivity to injection timing although the trend shown is similar with HC emissions increasing over the period of EOI 180 to 540^{o} CA.

For both injector types little sensitivity for NOx and fuel consumption is evident although absolute levels are different.

Since little sensitivity was measured with the designated injectors the EOI timing could be made based on dynamic engine performance considerations. When applying sequential fuel injection to an engine it is desirable to inject fuel as late as possible during a cylinder cycle so that the injected quantity can most closely match that required. EOI timing was therefore chosen as 30^{o} BTDC on the non-firing cycle, i.e. just before intake valve opening.

This injection timing was retained throughout the ensueing test work.

These injection phasing considerations are based largely on pseudo-static considerations. The possibility therefore exists for these considerations not to hold true during transient engine operation. This may be particularly relevant with respect to fuel wetting of the intake port walls, during transients and possibly during cold start operation. However, transient end of injection timing control is not a feature of the MEC system, nor is it thought to have been investigated by other workers.

5.2.3 Part Load Performance

The comparison of injector type under part load conditions is shown in figures 19 to 58 which show the mixture range curves at the seven keypoint engine conditions together with three ignition timing "sequence" tests. These results generally demonstrate that with the correct injectors brake thermal efficiency improves, especially at leaner running conditions, HC emissions reduce by up to 3 to 4 g/Kw h and NOx emissions increase, particularly in the range 0.9 to 1.0 equivalence ratio. Another consistent trend shows the MBT ignition timing to reduce.

The changes in HC emissions correlate well with those observed during the injection timing sensitivity tests. However the changes of NOx emissions, thermal efficiency and ignition timing indicate a change of combustion characteristics. Such changes have been observed on a number of engines where fuel injection characteristics have had a marked effect on the combustion process and whilst this is a recognised phenomenon, insufficient work has been done in this area to identify the controlling parameters.

5.3 Comparison with Carburetted Engine Performance

The performance of the engine with the correct fuel injectors is compared in this section with that previously measured by Ricardo on the same engine when fitted with a carburetter (1).

5.3.1 Full Load Performance

To assess the full load performance the engine was run with wide open throttle over the speed range with the mixture strength and ignition timing optimised for best torque at each speed. The results are shown in figures 59 - 62 where it is evident that the BMEP and power is significantly increased when compared to the carburetted levels. Maximum BMEP increases from 10.1 to 10.7 bar and peak power at 90 rev/s increases by 8 Kw to 59 Kw. The improved high speed volumentric efficiency is due to the improved intake manifold design possible for a port injected engine while higher brake thermal efficiency is attributed to better fuel distribution between cylinders.

The carburetted engine had exhibited little sensitivity to pre-ignition with ignition timings 10^{o} in advance of MBT possible over most of the speed range. Although the injected engine could also be run with MBT ignition over the speed range some sensitivity to pre-ignition was experienced whilst running with optimum mixture strengths above 60 rev/sec. This increased sensitivity may be as a result of the higher power output. To reduce the risk of pre-ignition richer mixture strengths were utilised at high engine speeds.

5.3.2 Part Load Performance

Direct comparison of the response to mixture strength was possible at a limited number of part load test conditions where the speed and load values coincided with those previously used. A comparison of the response to mixture strength and ignition timing at idle is also made. These results are shown in figures 63 - 78.

The mixture range loops show improvements in thermal efficiency for the injected engine, particularly at the low load condition, and these may be attributed to improved mixture distribution and the direct effect that fuel injection characteristics have been observed to have on this engine. The combustion process is certainly changed with ignition timing for MBT reduced by up to 10^{o} CA for the injected engine. This indicates a shorter combustion period, further substantiated with reduced exhaust gas temperatures. HC emissions tend to be lower whereas NOx emissions are similar at lean mixtures. No significant advantages in lean limit were measured suggesting that this was not a significant problem with the carburetted engine under part load conditions. In both configurations the engine was able to tolerate very lean mixtures, typically to 0.6 ER. Mixture settings for maximum brake thermal efficiency were also similar to that with the carburetted engine at about 0.7 equivalence ratio.

The result of a mixture range loop under idling conditions showed the injected engine to have a very distinct advantage. The tolerance to dilution was significantly improved and this difference is associated with fuel preparation. The very low gas velocities predominant under these conditions can result in poor fuel preparation with a carburetted system. These results are also significant in the context of oxidation catalyst application since the idle condition can be set lean of stoichiometric ensuring oxidation conditions. This would not have been possible with the carburetted engine without an additional air device.

The response to ignition timing under idling conditions shows the injected engine to have little sensitivity to ignition timing with the fuel consumption varying little more than 2% over a range of ignition timing from 30^{o} to 5^{o} CA BTDC. HC emissions remained consistently lower than with the carburetted engine.

5.3.3 Exhaust Gas Recirculation Tests

A description of the EGR control system is given in Section 2.8 and a schematic layout is shown in figure 4.

For this part of the programme, EGR loops were to be carried out at equivalence ratios of 1.0, 0.9, 0.8 and 0.7 at each of the 6 part load keypoint test conditions. The results are shown in detail in figures 79 - 102.

Only a limited amount of EGR work was carried out with the carburetted engine and a comparison of this is made in figures 83 and 84. These figures show that at 0.8 equivalence ratio the carburetted engine had relatively poor EGR tolerance and this was attributed largely to fuel and EGR distribution problems. EGR tolerance with the injected engine is high, and up to 30% EGR could be tolerated with stoichiometric fuelling. Over the equivalence ratio range tested from 1.0 to 0.7, EGR tolerance reduced as the combined (air + EGR) dilution tolerance of the combustion system was reached. The exception to this was the tolerance at higher speeds and loads where high rates of EGR were not possible because there was insufficient pressure drop across the engine. This was an anticipated limitation which did not affect the final EGR strategy.

The response of the engine to EGR was considered to be typical for its type and the results showed that considerable reductions in NOx would be possible with little increase in fuel consumption. The interaction between HC and NOx emissions with fuel consumption at the part load test conditions is shown in figures 103 to 114. These trade offs exhibit similar trends at each test condition. For NOx control it is clear that a given level (g/kWh) of NOx emission can generally be obtained using a number of combinations of mixture strength and EGR. As expected, strategies with richer mixtures, and higher EGR rates, result in reduced economy for a given NOx rate. The HC emission and fuel consumption trade off curves clearly demonstrate the conflict between HC emission, NOx control and fuel consumption. The fuel efficient low NOx strategies result in high levels of HC strategies

The choice of EGR strategy would therefore be dependant on the limits of fuel economy penalty, increase of HC emissions, and driveability. The latter could not be assessed during this testbed programme. However, it was evident that a minimum NOx strategy, predominantly attained by running with lean mixtures and high EGR rates, would result in very severe increases in HC emissions often over 100%. This would result in an unacceptable strategy and a compromise solution between NOx reduction, fuel economy penalty, HC emission increase and driveability would have to be developed.

5.4 Engine Performance Mapping

5.4.1 Best Economy Strategy

The test results from the mixture range tests at the keypoint conditions indicated that highest brake thermal efficiency was achieved at an equivalence ratio of 0.7. It was considered, from vehicle experience of applying control strategies to this engine type (18) that a control strategy with 0.7 equivalence ratio could be developed in a vehicle for satisfactory driveability given sophisticated transient fuelling compensation. Ignition timing would need to be optimum as retard from MBT has been demonstrated to degrade engine response to an unacceptable level.

The engine was run over the load range at 20, 40, 60 and 80 rev/s to determine MBT ignition timings with 0.7 ER up to 900 mbar absolute inlet manifold pressure. Above this, the mixture was progressively enrichened for full load conditions. The fuelling level and ignition timing required for each load and speed was entered in a set of MEC maps. Following this the engine was run with the fuelling level and ignition timing automatically controlled by the MEC to obtain performance and emissions readings from which a set of specific performance maps was derived (see figures 115 - 120).

These results show that the engine control parameters may be precisely calibrated over the entire operating range of the engine. The equivalence ratio map clearly shows this where the desired mixture strengths can be achieved over the range of operation. This precise calibration results in efficient engine operation and a maximum brake thermal efficiency of over 33% was achieved. Comparison with the carburetted engine shows measured improvements of efficiency of up to 10% under low load conditions.

The HC map shows the adoption of lean mixtures and MBT ignition timing results in high levels of HC emissions under low load conditions. NOx levels during lean operating conditions, below about 6.0 bar are low, typically half that achieved with the carburetted EGR version of the engine. NOx levels peak in the range 7 to 9 bar where fuel/air mixtures correspond to those for maximum NOx production.

5.4.2 Reduced NOx Strategy

In order to determine an effective strategy for reduced NOx using exhaust gas recirculation a Ricardo computer program "CONTROL" was used to analyse the test results from the EGR loops. (A brief description of this program was given in Section 4.4).

The objective of this analysis was to devise an alternative control strategy that would result in a maximum reduction in NOx emissions with minimum penalties of HC emission and fuel consumption. Exploration over the range of mixture strengths and EGR rates established the operating envelope shown in figure 121. It is clear from this data that the best economy strategy already represents a strategy towards the lower range of NOx emissions possible with MBT ignition timing. Furthermore, there is a strong link between reducing HC and increasing NOx emissions indicating that a simultaneous reduction of both is difficult to achieve, and the direction for minimum NOx is similar to that for fuel consumption penalty indicating that reduced NOx will result in increased fuel consumption. This simple keypoint model also indicated that the limits presented by the test data resulted in a minimum NOx level of about 1 g/mile for the Federal Test Procedure if MBT ignition timings were used. From this trade-off data it was decided to pursue a strategy which would result in a minimum NOx strategy without a significant HC emission penalty i.e. towards minimum NOx as shown in figure 121.

The 'CONTROL' program enabled the equivalence ratio and EGR rate for the required strategy to be identified for the keypoint loads and speeds. This indicated that relatively rich mixtures of 0.8 to 0.9 equivalence ratio, should be used with high rates of EGR to obtain NOx reduction without penalising HC emissions. This strategy, using MBT ignition timings, resulted in a CYSIM NOx level prediction of 1.07g/mile with a level of HC emissions similar to the best economy strategy. It was evident that a control strategy with MBT ignition timing would not enable the project goal of 0.7 g/mile NOx to be achieved. The primary reason for the difficulty in achieving 0.7 g/mile NOx compliance was considered to be the choice of vehicle which resulted in a poor power/weight ratio and subsequent high engine duty cycle. It was therefore necessary to apply 7^{o} - 10^{o} ignition retard in the mid-upper load range from 20-60 rev/s in order to achieve the required level of 0.7g/mile NOx. This strategy resulted in a reasonable compromise between NOx reduction, HC emissions and fuel consumption. However, experience has shown that when operating at, or close to, the dilution tolerance limit of an engine, the use of ignition retard can result in a significant deterioration of driveability.

Following calibration of the control strategy the engine was then run with auto fuelling/auto ignition/auto EGR to obtain performance and emission readings from which the Reduced NOx strategy specific performance maps were derived (see Figures 122 - 128).

These Figures show that up to 15% EGR is used under medium load conditions and part load equivalence ratios are in the range 0.8 to 0.9. Brake thermal efficency was slightly reduced with the maximum reduced by 2% to 31%. Comparison of the maps shows that at low load conditions significant reductions have been achieved but increased HC emissions are evident at higher loads. Conversely NOx emissions are somewhat increased at low load conditions although they remain at a low absolute level but are very significantly reduced in the medium to high load range where the peak NOx level of 12 g/kW h is reduced to 2 g/kW h over the range of engine speed using during the FTP drive cycle.

5.5 Development of Transient Fuelling Strategies

Conventional practice is to carry out the development of transient fuelling strategies with the engine installed in the vehicle and utilising a chassis dynamometer. This is to enable driveability to be assessed in addition to modifying the fuelling characterisics to give smooth mixture strength transitions. However, the testwork with the engine installed in the vehicle was to be carried out by EPA and was not part of the test programme at Ricardo. It is expected therefore that further development of the control strategy maps would be required with the car on the chassis dynamometer and on the road to achieve the desired driveability and emission characteristics.

In order to simulate transients on the test bed, moveable "stops" were fitted to the throttle actuator so that the engine load could be rapidly changed from one known test condition to another. Tests were conducted at 20, 30, 40 and 50 rev/sec with several different load increments. Throttle movements were rapid with a transition period of typically 0.2 s. This type of load transition is most demanding on the control system and experience has shown that the needs of slower transitions are also satisfied. The instantaneous exhaust air/fuel ratio was measured by a Lambdascan instrument and displayed on a chart recorder. The test conditions chosen were representative of those experienced during the LA4 drive cycle. Modifications were made to the "H" "C" and "K" maps in the MEC (see Appendix 2 for definition) so that a smooth transition in equivalence ratio was achieved when "accelerating" from one test condition to another. The objective being to avoid rich or lean mixture excursions from those defined during the steady state calibration.

Examples of the transient performance of the engine whilst on the test bed are shown in figure 129.

The transient fuelling algorithm in MEC is based on a manifold wall wetting model (19). The model shows us that the fuelling compensation required during an acceleration is mathematically the reverse of that required during a deceleration. The results clearly show that having optimised transient fuelling during the acceleration the control of fuelling is equally well defined. The limit on deceleration fuelling control is that negative fuelling rates are not possible so that some rich excursions may be experienced under certain operating conditions.

5.6 Development of Cold Start Strategy

The `X' map in the MEC enables compensation to be made to the fuelling and EGR rates for cold starting and warming up by sensing the coolant or inlet manifold temperatures. The objective of the warm-up control strategy development is to maintain driveability with minimum fuelling and emission penalties.

A throttle bypass valve was fitted to the engine to bleed air past the throttle to compensate for the increased idle air required under cold running conditions. This valve is sensitive to engine temperature and also has internal heating thus giving a time and temperature control regime.

Because of the location of the fuel injector close to the inlet valve it was not anticipated that the provision of evaporative devices would be either practical or necessary to achieve satisfactory starting performance. The intake of liquid fuel and the high compression ratio was expected to result in adequate cold start behaviour down to moderate temperatures. Experience with the engine showed this to be the case and although it was not possible to carry out starting tests under very low temperatures adequate performance was evident down to 10°C.

The development of a cold start and warm-up strategy is dominated by the requirement for driveability. The additional transient fuelling compensation is predominantly required to account for the larger amounts of liquid fuel in the intake manifold and this can be compensated for using the transient fuelling strategy. However, this type of development is not readily carried out on a test bed and although cold start and warm-up strategies have been implemented for the methanol engine it is anticipated that this will be an area of significant further development during the vehicle application stage.

The steady state fuelling has been calibrated to be about stoichiometric immediately following a cold start and a trace of air/fuel ratio with time following a cold start is shown in figure 130.

EGR is not required during the initial stages of the warm-up period since NOx levels are low and EGR tolerance is poor at low temperatures. A strategy for the gradual introduction of EGR above a water temperature of $40^{\circ}C$ has been implemented. This strategy will also require verification and development during the vehicle application.

5.7 Overrun Fuelling

The use of port fuel injection facilitates overrun fuel cut off enabling a fuel saving and HC emission reduction under these conditions. This strategy is commensurate with an oxidation catalyst approach. Both best economy and reduced NOx control strategies have been calibrated using overrun fuel cut off as shown in appendices 3 and 4 where this condition is indicated by OVRUN on the fuelling maps. This instruction causes a step change of fuelling level ensuring that intermediate air/fuel ratios are not encountered by the engine. Conversely the demand for engine power will result in a step increase of fuelling to the desired level. Clearly this is a further area where driveability and transient fuelling optimisation may require further development.

5.8 CYSIM Simulation

The two strategies developed for the engine were entered as data to the CYSIM drive cycle program. The vehicle details were for the Audi 5000 vehicle as described in Section 4.5. These results are summarised in Table II for the FTP LA4 drive cycle and are compared with the following:-

Simulation No.	
1 and 2	The carburetted version of this engine when fitted to a VW Rabbit vehicle.
3 and 4	The current (injected) engine fitted to a VW Rabbit vehicle.
7	Audi 5000 diesel engine vehicle.

The results show the fuel injected methanol engine to exhibit a significant economy advantage over the carburetted engine even when fitted in an Audi 5000 vehicle which has a much higher inertia weight than the VW Rabbit vehicle.

The NOx emissions reduce by 0.8 g/mile in the VW Rabbit vehicle when changing from carburettor to injected fuelling. There is however a penalty 0.5 g/mile NOx if the injected engine is fitted in the Audi 5000 vehicle.

The EGR strategies exhibit the same trend in NOx emissions and fuel consumption as those outlined above for the 'Best Economy' strategies. The injected Audi 5000 maintains a fuel economy advantage over the carburetted Rabbit vehicle.

It should be noted that the results for the injected VW Rabbit vehicle are not representative because the control strategies were optimised for the Audi 5000 vehicle. The change of vehicle weight would require re-optimisation of the engine control strategy since different engine speeds and loads are used.

The comparison of the diesel engine vehicle shows this to have low HC emissions but NOx emissions indicate that optimisation of the control strategy and/or EGR is required. A comparison of the fuel consumption shows the methanol concept to be favourable.

The acceleration times shown in Table II are also derived from the CYSIM program and are calculated as follows:-

The engine torque curve and the speeds between which the acceleration time is required are entered into the program.

$$\text{Acceleration} = \frac{Fw}{m}$$

where Fw = force applied to the road by the driving wheels under the prevailing conditions.

m = vehicle mass

The program calculates the force to accelerate the vehicle starting at the driving wheels and allowances are made for tyre slippage, efficiency losses in the final drive and gearbox, vehicle drag and engine and wheel inertia. Working in one second increments the program calculates the required engine speed and torque for acceleration. The program iterates to match the required force to the torque available from the engine under the prevailing conditions. If the engine speed rises above the set limits the next gear is selected. The program finally calculates the acceleration time between the given vehicle speeds.

The acceleration times for all three vehicles are thought to be pessimistic due to the fact that the CYSIM program cannot model clutch control and wheelspin at the start of the accelerations. This means that maximum torque cannot be applied during this period.

The CYSIM calculated acceleration times for the methanol injected version of the engine are also compared in Table II. These show that there is a significant advantage if the engine is fitted in a VW Rabbit vehicle rather than the Audi 5000 vehicle for both 0 - 50 and 30 - 50 mph accelerations. However, the Audi 5000 vehicle still retains a distinct advantage over the diesel engined Audi 5000.

5.9 General Engine Condition

Previous work with the carburetted version of the engine had shown the tolerance to running with methanol to be satisfactory with no areas for major concern identified. This situation remained for the fuel injected engine development phase.

The limited area of the intake port exposed to methanol was inspected following the engine development phase to show that there were no deposits attributable to the use of methanol fuel.

The major differences between the engines are in the fuel handling system and this is where some problems were encountered. Those components specified as methanol proof i.e. fuel filter and fuel pressure regulator have performed as such through the project with the engine development period spanning more than 1 year with a 6 month break in between. Some fuel injector failures were encountered but subsequent analysis by Bosch has revealed that these were due to corrosion of the coil wire. Since this area is not normally in contact with methanol the failures are not associated with the use of methanol and as such are unexplained. The fuel pump was recognised as having a limited life and was replaced at intervals of about 3 months. Failure was not encountered during the test programme.

6. SUMMARY OF ENGINE DEVELOPMENT WORK

The Bosch/MEC ignition system was shown to result in similar performance compared with the A.C. Delco ignition system and was adopted for the subsequent engine development program. This result showed that the high energy ignition system previously used did not offer any significant advantage to the methanol engine concept.

Compared with the carburetted engine the injected engine has a much reduced ignition requirement at part load by 6 to 10 degrees with reduced HC emissions and higher brake thermal efficiency. Some of these differences were evidently directly due to the mechanism of fuel preparation since the engine was shown to be sensitive to fuel injection rate and timing.

At full load the changes to mixture preparation, fuel distribution and intake manifold geometry led to a significant improvement in BMEP above 50 rev/s and an increase in brake thermal efficiency of 2.5% over the speed range. Volumetric efficiency is however some 5-8% lower at 20 to 40 rev/s because the manifold geometry favours high speed running.

Pre-ignition was encountered whilst running at optimum mixture strength above 60 rev/sec at full load. This caused slight damage which necessitated fitting a new piston. This was an unforseen problem as test work with the carburetted engine had indicated that the engine could be over advanced by up to 10^{o} CA before encountering preignition when BN-60Y sparking plugs were fitted. Richer mixtures were later used to prevent reoccurance of pre-ignition.

The mixture strength for best economy without significant HC emissions penalty was generally found to be at an equivalence ratio of 0.7 and this mixture strength was used for the "Best Economy" maps. This equivalence ratio was the same as that established as optimum for the carburetted engine but maldistribution and lack of adequate transient fuelling control meant that this lean potential could not be utilised. This was not the case for the injected engine so that the full potential of the engine concept could be realised in the vehicle application. The result of this was a fuel economy improvement of 18% despite the increase of vehicle weight from 2500 to 3250 lbs.

A second control strategy, using EGR and $6\text{-}10^{o}$ ignition timing retard was identified to reduce the NOx emission level below that obtained with best economy and comply with the project objectives of less than 0.7 g/mile NOx. The control strategy optimisation showed that NOx emissions could be reduced by 62% with an insignificant increase of HC emission by selecting a suitable strategy for EGR, mixture strength and ignition timing. This strategy increased predicted fuel consumption by a penalty of 6%. It was felt that the low vehicle power/weight ratio, which at about 43 kw/tonne is well below that typical of current gasoline engine vehicles at 50 to 60 kw/tonne, combined with lean air/fuel mixtures, EGR and ignition retard would result in a vehicle concept whose driveability may be unsatisfactory.

Simulation of engine transients was carried out on the test bed by actuation of the throttle lever between "stops". A smooth transition between engine loads was achieved by calibration of the MEC maps. It was well recognised that it was not possible to fully calibrate transient engine performance on the engine testbed and further development of engine transients would be required when the engine is fitted to the vehicle by EPA.

The engine "cold start strategy" was set up to enable an unaided start to be achieved at an ambient temperature of $10^{o}C$. Tests were unable to be conducted at lower temperatures because the test cell had no cooling facility. Initial strategies for warm-up compensation and modulation of EGR rate during the warm-up phase were also devised using testbed data and Ricardo experience gained from similar applications. Again this area is recognised as one where further development during the vehicle phase will be required.

The condition of the engine and fuel handling equipment indicated that adequate tolerance to methanol was evident. The intake system was free of attributable deposits.

7. CONCLUSIONS

The application of electronic sequential fuel injection and electronic engine management to the optimum engine for methanol utilisation was successfully carried out during this project.

The effect of fuel injection was to improve the engine performance when compared to that previously obtained with the carburetted version of the engine. At full load maximum BMEP increased by 6% and peak power output by 16%, however some increased sensitivity to pre-ignition was evident. Under part load conditions brake thermal efficiency increased and HC emissions reduced. The engine was noted to be sensitive to fuel injection characteristics such as fuel injection rate.

The part load vehicle calibration for best economy was able to be carried out at a leaner mixture strength than that of the carburetted engine, 0.7 ER, instead of 0.8 ER due to improved mixture preparation and distribution with sequential fuel injection, as well as the sophisticated transient fuelling control possible with the Ricardo MEC unit.

The use of alternative mixture strengths mapped EGR and ignition retard showed that a control strategy was possible to enable NOx emissions to be reduced by 62% without a significant HC emission increase and a fuel economy penalty of 6%. This control strategy was considered to be representative of what could be achieved for a 3250lb vehicle over the LA4 drive cycle. The vehicle results were predicted as

	HC	NOx g/mile	CO	Methanol Fuel consumption miles/US gallon
Best economy strategy	1.92	1.75	3.37	16.3
Reduced NOx strategy	1.82	.67	14.52	15.4

The selection of vehicle by EPA for application of the methanol engine resulted in a poor power/weight ratio and this may result in poor vehicle driveability compared to that typical of current automotive practice.

Transient and cold start strategies were carried out on the test bed and were set up so that unaided starts at an ambient temperature of 10°C and smooth transitions of air/fuel ratio between engine loads were achieved. It was recognised that some modification of the transient and warm-up strategies will be necessary to optimise driveability when the engine is installed in the vehicle.

The condition of the engine and fuel handling equipment following the test programme indicated satisfactory tolerance to methanol.

8. RECOMMENDATIONS FOR FURTHER WORK

1. Following installation in the vehicle the cold start, warm-up and transient fuelling strategies should be verified and developed for driveability. The warm-up EGR strategy should also be developed.

2. The performance of the engine and control system when fitted in the Audi 5000 vehicle with a suitable oxidation catalyst should be assessed.

3. The engine concept has been shown to be particularly sensitive to fuel injection characteristics. Further investigation of fuelling characteristics should be carried out to investigate the potential.

4. The cold starting characteristics at very low temperatures should be evaluated including the need for any heating devices, and fuel spray patterns.

5. The methanol engine should be applied to a more suitable vehicle and the control strategies reoptimised.

6. An investigation into the affects of modulation of end of injection timing control during engine transients and cold start operation should be carried out.

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TABLE I

FUEL SPECIFICATION

METHANOL (BS 506:1966)

Appearance	Clear, colourless, free from suspended matter and sediment.
Relative Density @ 15.5/15.5°C	0.798 - 0.795
IBP°C	>64.5
95% @ °C	<65.25
FBP°C	<65.5
Water Content	<0.5% by weight (measured - 571ppm)
Aldehydes and Ketones	<.015% by weight, as acetone
Alkalinity	<.0005% by weight, as ammonia
Acidity	<.003% by weight, as formic acid
Sulphur and Sulphur Compounds	<.0001% by weight, as sulphur
Composition % by weight	
Carbon	37.5
Hydrogen	12.5
Oxygen	50.0
Octane Quality (from literature)	
RON	104-114
MON	87-97
Stoichiometric Air/Fuel Ratio	6.46
Measured Calorific Value kJ/kg	19940
Latent Heat of Vaporisation kJ/kg (from literature)	1100

TABLE II

PREDICTED FTP LA4 RESULTS USING CYSIM

DRIVE CYCLE SIMULATION PROGRAM*

Vehicle/Engine/Strategy	HC (g/mile)	NOx (g/mile)	CO (g/mile)	miles/US gal. Methanol/	miles/US gal. Gasoline Equivalent	Accel.time (secs) 0-50 mph	Accel.time (secs) 30-50 mph
1.VW Rabbit/Carb/0.8 ER	1.61	2.07	1.17	13.85	28.61		
2.VW Rabbit/Carb EGR	1.35	0.98	1.75	14.76	30.49		
3.VW Rabbit/Injected/0.7 ER	1.95	1.29	3.35	16.84	34.80	15.0	9.1
4.VW Rabbit/Injected/EGR	1.70	0.59	8.77	16.48	34.05	15.0	9.1
5.Audi 5000/Injected/0.7 ER	1.92	1.75	3.37	16.30	33.68	18.0	11.0
6.Audi 5000/Injected/EGR	1.82	0.67	14.52	15.40	31.82	18.0	11.0
7.Audi 5000/Diesel no EGR	0.11	2.15	-	-	32.85	22.9	14.4

* Steady state simulation - no cold start adjustment

Note: VW Rabbit - 2500 lbs inertia weight
Audi 5000 - 3250 lbs inertia weight

APPENDIX I

MEC APPLICATION

DP83/1097
Unrestricted

ENGINE CONTROL STRATEGY DEVELOPMENT USING THE RICARDO MICROPROCESSOR ENGINE CONTROL UNIT

C.A. CLARK & C.D. de BOER

ABSTRACT
The advent of electronic management systems for the control of internal combustion engines requires a systems approach to engine and control unit design. To augment its traditional expertise in the field of internal combustion engine design and development, Ricardo have developed a Microprocessor Engine Controller (MEC) for the development of engine control strategies.

Emphasis has been placed on producing a unit capable of accepting a large number of control input variables and a wide range of possible control outputs. The unit can thus be used to control fuelling, timing and/or EGR rates on both diesel and gasoline engines.

An ergonomic user interface allows the ready modification of control parameters during engine running both on the test bed and in the vehicle and these can be retained within the unit's non-volatile memory for later examination by the test engineer.

Paper to be presented at the International Symposium on Automotive Technology and Automation - ISATA - Cologne, 19-23 September, 1983.

CONTENTS

ENGINE CONTROL STRATEGY DEVELOPMENT USING THE RICARDO MICROPROCESSOR ENGINE CONTROL UNIT

1. INTRODUCTION

Engine development has traditionally been a relatively slow process where innovation and change has taken some time to permeate through the process of design, development and manufacture. In the last five years, however, a dramatic change has taken place in the area of electronic control for gasoline engines particularly in the USA but also in Japan and Europe. This change has been largely driven by emissions and fuel economy legislation but recently great interest has been shown in applying this technology to new areas including diesels and drive train control. Such trends mitigate against a traditional sub-assembly approach to automotive engineering and suggest that in future a systems approach will need to be applied as each constituent of the vehicle is inter-connected via the electronic control unit. Whether the electronic control/display function is carried out centrally or in an arrangement using distributed computing elements, remains to be debated. The impact of these changes needs to be embraced at virtually every stage of the conception, design and production of the automotive system.

Ricardo are well known for their involvement in the research, development and design of internal combustion engines and in order to fulfil this role with future generations of automotive and off-highway applications of internal combustion engines, have developed an in-house Microprocessor Engine Controller (MEC). This is intended to provide Ricardo and client funded projects with the means to evaluate the impact of electronic control on areas of interest in a given system and to arrive at a production strategy where necessary. The Ricardo MEC provides a cost effective means of evaluating the benefits of engine management systems without the large cost associated with the development of the electronic control system itself.

2. DESIGN PHILOSOPHY

2.1 Overview

Ricardo have traditionally been active in research and development of both diesel and gasoline engines. The control device produced thus had to be suitable for application to both engine types and also to a wide number of variations within these broad classifications. This is conceptually not difficult to achieve as the basic requirement of a system into which some input variables are fed, and by means of which some dependent variables are derived, is common to all engine types. However, care has to be taken that a wide variety of input and output sensors can be catered for with the minimum of extraneous conditioning hardware. For example, intake manifold pressure may well be chosen as a signal with a dependence on load for the gasoline engine but in non-throttled diesel engines the load dependant signal must be derived in some other manner. In view of this a unit was designed with a variety of possible input parameters to cover not only analogue voltages and on-off digital inputs but also to allow frequency and time parameters to be measured.

2.2 Basic Strategy Implementation

The basic engine control strategy is based on the framework of a series of two-dimensional maps, there being at least one two-dimensional map for each controlled variable. These maps have for their axes engine speed and a load dependent variable. The maps can be dimensioned to facilitate varying requirements. Initially, the maps have been arranged as a 9 by 10 load/speed matrix. The matrix resolution can be modified readily in software and could be increased by a large factor if this was considered necessary. The required controlled ouptut is then derived by a series of linear interpolations based on the actual speed and load values as measured at a given time. Initially the unit is being applied to the Ricardo family of research engines based on the VW 1.6 litre engine and manifold pressure has been selected as the load dependant variable, although other suitable variables such as air-flow could easily be accommodated if desired. Correction factors for temperature and transient speed and load conditions are applied to these basic maps. This is an area of considerable interest and room for flexible transient control strategies has been accommodated in the design of the unit. Currently transient fuelling strategies have been implemented for both single and multi-point injection systems on this family of gasoline engines.

2.3 The Control Element

The system is primarily aimed at a research and development role, the hardware and techniques used, however, are intended to typify the principle of approach being used in the automotive industry. The Texas Instruments TMS9995 microprocessor, a modern, fast 16 bit processor, was selected as the control element for the MEC unit. This provides the capability of implementing complex control strategies and additional operator features to enable the user to inspect system variables.

2.4 Operator Facilities

The user interface presents the operator with both measured parameters and the derived values being delivered to the engine in engineering units. Continuous updates of speed, manifold pressure and engine temperatures are provided as is a display of the primary controlled variables of ignition timing and fuelling levels. For testbed operation a conventional visual display unit is used but in order to provide this facility in the vehicle a custom display unit has been installed in the console to enable the parameters to be monitored.

From the outset it was considered important to provide a means of altering the maps whilst the unit was actually controlling the engine. In order to achieve this the user may alter individual map entries, areas of the map, or the complete map by means of the visual display unit keyboard. The software for the unit is based on a real-time, multi-tasking, operating system which enables the modification of the maps to be carried out whilst the main function of controlling the engine is maintained. This feature enables development of empirical features, such as driveability, to be developed in the vehicle outside the laboratory. In order to benefit and retain the modifications developed in this manner, a facility has been incorporated to retain the maps in non-volatile Electrically Erasable Programmable Read Only Memories (EEPROMs) for later utilization and analysis.

The operator may select (in the software) any of the control variables, such as fuelling, to be output as an analogue signal. Four such channels are presently available and provide a powerful development tool when optimizing transient strategies. The analogue signal ports may alternatively provide a closed-loop engine control facility such as idle speed control. In this mode the control data is derived from engine input variables and the look-up and modify routines described earlier.

In addition a 'hold' facility enables the operator to store the engine operating condition for any given cycle. This facility is useful in locating intermittent driveability problems which may subsequently be analysed or reproduced from the knowledge of the engine condition.

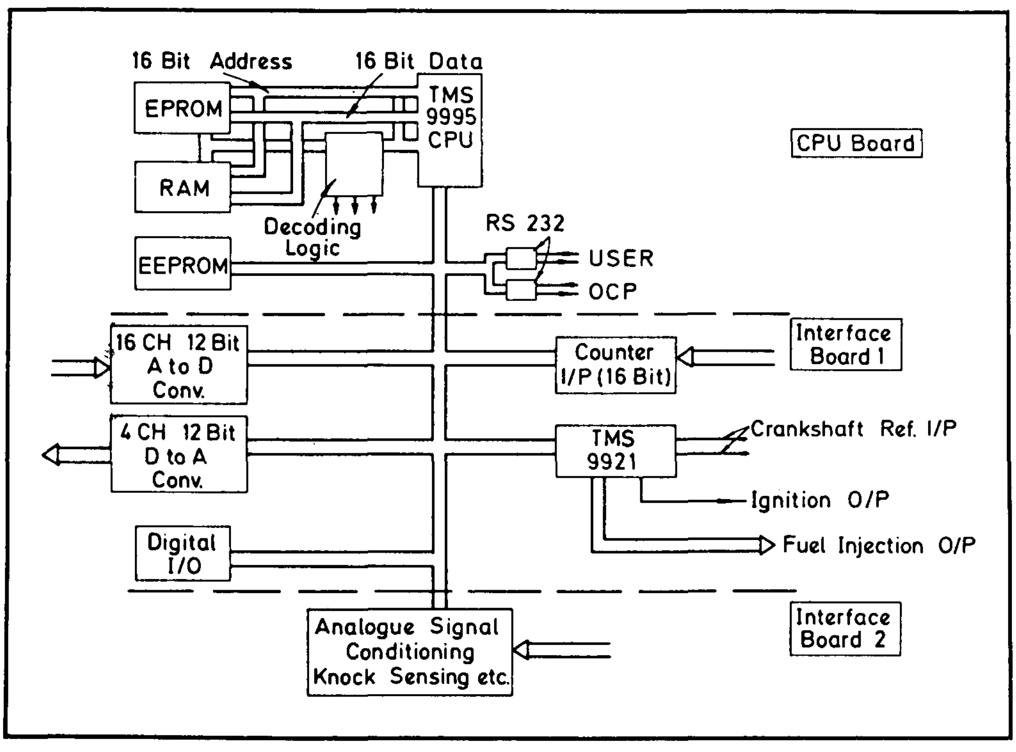

Fig.1 Microprocessor Engine Controller Functional Diagram

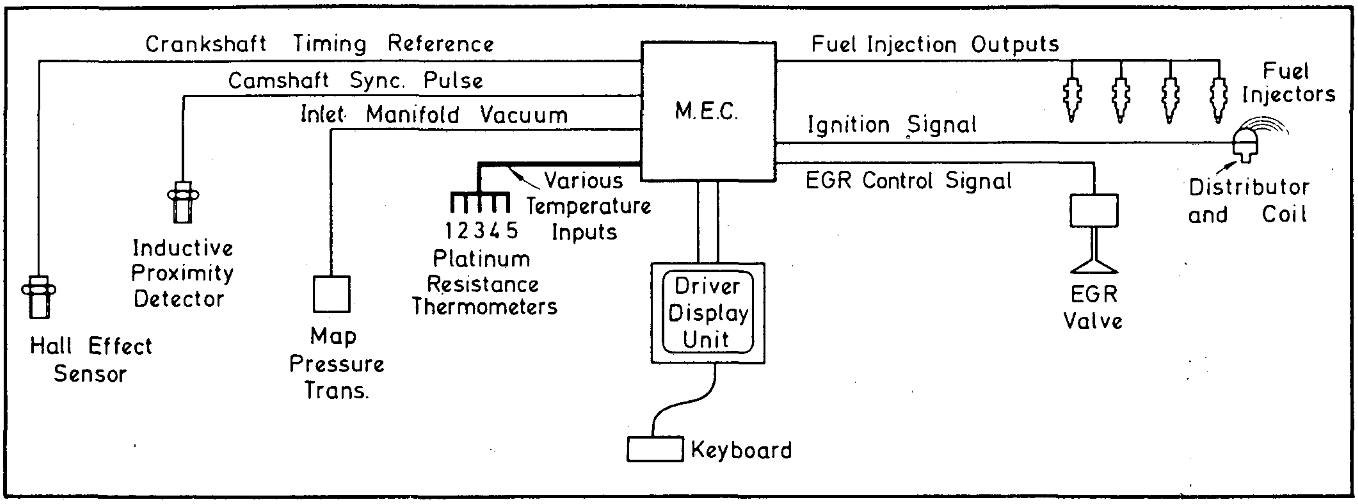

Fig.2 Microprocessor Engine Controller General Installation Scheme

2.5 Knock Capability

To enable maximum utilization of fuel quality to be achieved it was considered important to include a system of knock control. Signals from a knock sensor are used as a further control variable to modify engine control parameters.

3. IMPLEMENTATION

3.1 Hardware

The system consists of a ruggedized box and three basic circuit cards. Fig.1 shows the overall system layout within the MEC unit and the inter-relation between the boards.

3.2 Central Processing Unit

The Central Processing Unit (CPU) card is based upon the Texas Instruments' TMS9995 processor. Running on a 12MHz crystal this provides the computing requirement for the whole MEC unit. The CPU card also contains 16KB of Random Access Memory (RAM) for variable storage and program workspace, 24KB of Erasable Programable Read Only Memory (EPROM) for program and initial map storage and 12KB of EEPROM for retention of maps. The latter provides the capability of storing up to 88 different ignition, fuelling or EGR maps within this non-volatile, alterable medium.

3.3 Interface Board 1

The board contains all necessary circuitry to interface the processor to the conditioned engine inputs and outputs. At the heart of this board there is a TMS9921 automotive control element. This chip contains the necessary logic elements to measure speed and to provide the pulse outputs required for fuelling and timing. Analogue to digital conversion is provided in the form of a 16 channel 12 bit conversion system. To complement this, four channels of 12 bit D/A conversion are also provided. Accuracy of conversion is greater than needed for a production unit but provides a means of measuring and controlling accurately the input and output parameters. The manifold pressure signal contains cyclical variations and in order to average these the signal is fed into a voltage to frequency converter. This output is then counted over one engine cycle. As the engine speed is known the counter reading can then be translated into a real pressure value. In this manner an instantaneous average of the manifold pressure is obtained without the attendant delay associated with a conventional filter arrangement.

3.4 Interface Board 2

This board provides the necessary signal conditioning for the actual transducers used on the engine. Currently this includes a variety of inductive, Hall effect and other proximity type detectors, platinum resistance and thermocouple conditioning and piezo-resistive element excitation and amplification. The board also has a generous prototyping area for conditioning other sensor inputs, for example the recent trend towards instrumented needle lift on diesel injectors as a measure of fuelling/load could easily be accommodated.

The unit is then completed by a series of injector drive units for gasoline engine applications and power supply modules to derive the necessary supplies from a vehicle battery.

3.5 Software

The software is based around a multi-tasking, real time operating system, already used in-house for a variety of other real time tasks. The system provides the ability to split the control and monitoring into a variety of separate programs or tasks. These tasks can then be tested independently. An efficient task scheduler ensures that the tasks which have the highest priority are serviced first and uses the rest of processor time to service tasks where timing is less stringent.

4. TEST EXPERIENCE

4.1 Initial Objectives

Application of the MEC unit to the Ricardo research gasoline engines was a prime consideration. The system is thus capable of providing ignition timing, fuelling control and EGR rate modulation. The unit also has the capability of operating a cold start enrichment strategy.

As control of engines employing the High Ratio Compact Chamber (HRCC) combustion system was contemplated, the inclusion of knock detection was considered important.

4.2 Testbed Use

The MEC unit was first tested on a 1.6l VW engine installed on a testbed. The cylinder head was adapted to take multi-point injection equipment and the existing ignition modified for use with electronic control. The engine was then optimized for fuelling levels and ignition timings and the values so derived were input into the MEC unit. Subsequent testing of the unit's performance indicated that it produced the optimum fuelling and ignition timing. The unit functioned reliably and repeatably. Examination of the processor timing function indicated that the TMS9995 was only 12-15% utilized at 6000 rpm.

4.3 Vehicle Evaluation

Subsequently the unit has been evaluated in a vehicle using a similar engine. Apart from some installation problems the unit has proved satisfactory in operation. The facility for modifying the fuelling and ignition map values whilst in the vehicle has proven invaluable in improving driveability, fuel economy and emissions performance.

5. FUTURE EXPLOITATION

Future exploitation of MEC is based on the capability designed into the unit. The ability to monitor a large number of functions, whether these be engine based or elsewhere, together with the powerful, high speed, computing capability, allow a wide spectrum of applications to be undertaken.

Conventional engine parameter control through the use of look-up tables is enhanced by the software based modifying facility. The capacity of the system is such that many additional parameters may be controlled using the engine speed and load as a basis. EGR is an obvious candidate but the control of engine auxiliaries, such as turbocharger waste-gate or cylinder disabling, are readily applied.

The flexibility of the system as a development tool means that its application is not confined to purely electronic based systems. Based on the engine input parameters the MEC can be programmed to emulate mechanical systems. Changes in design can be readily accommodated in the software and the effects on engine running determined without the need for manufacture of prototype mechanical components.

The 'drive-by-wire' concept, where the direct control of the engine is replaced with an electronic link between driver and the engine offers many potential advantages. In terms of engine transient control the need for costly, high speed transducers and complex compensation routines is removed when the engine controller is in full control of the transient. The potential is there for reduced fuel consumption and emissions. Additional features such as cruise control may be readily incorporated. However, it is in the field of engine and transmissions matching where significant advances are currently being made. The need to match the demands of the engine and transmission to that of the driver is a complex situation where a system such as the one developed by Ricardo can provide a powerful development and diagnostic tool.

Further work is proposed into the development of EGR strategies on both gasoline and diesel engines and into advanced knock detection mechanisms.

6. CONCLUSIONS

Ricardo have developed a Microprocessor Engine Controller for the development of engine control strategies. The unit can be applied to both gasoline and diesel engines and is well suited to testbed and in-vehicle use.

The system has demonstrated its ability to be an effective tool in engine development and has illustrated its capability to act as an engine controller to implement complex control strategies.

CAC/CDdeB

Fig.3
Microprocessor Controller In-Vehicle Screen Display

MICROPROCESSOR ENGINE CONTROLLER Mk II.

ENGINE SPEED	**20.00**	**rev/s**
INLET PRESSURE	**500**	**mbar abs.**
IGNITION ADVANCE	30.00	deg. BTDC
INJECTION VOLUME	15.30	cu mm^3/inj
WATER TEMPERATURE	85	deg. C

★★★ FUEL INJECTION TABLE ★★★

INLET PRESSURE mbar abs.	**1000**	4000	4100	4200	4300	4400	4500	4600	4700	4800	5100
	900	2900	3000	3100	3200	3300	3400	3450	3460	3470	3480
	800	2550	2600	2700	2800	2900	2960	3030	3040	3050	3050
	700	2200	2250	2300	2400	2480	2520	2600	2700	2800	2900
	600	1875	1900	1950	2000	2050	2090	2130	2200	2250	2300
	500	1530	1530	1560	1590	1620	1630	1630	1620	1620	1620
	400	1230	1230	1230	1240	1250	0000	0000	0000	0000	0000
	300	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
	200	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
SPEED r/s		**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**

MODIFY ENTRIES (Y/N)?
SINGLE OR ALL (S/A)?
SURE (Y/N)?

FOR HELP PRESS	"H"
TO SAVE MAPS PRESS	"D"
TO DISPLAY FUELLING PRESS	"F"
TO DISPLAY TIMING PRESS	"I"

A TYPICAL DISPLAY ON THE USER TERMINAL IN THE VEHICLE

RICARDO
CONSULTING ENGINEERS

APPENDIX II

MEC USER NOTE

APPENDIX II

MICROPROCESSOR ENGINE CONTROLLER USER MANUAL

(For Software Revision 2.8.3)

Figures

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SUMMARY

This is the user manual for the Microprocessor Engine Controller (MEC).It supersedes Ricardo DP 84/1193. The manual outlines the purpose and function of the MEC. The use of the MEC maps to control engine fuel, ignition advance, etc, is described.

1. INTRODUCTION

Ricardo have developed a versatile Microprocessor Engine Controller (MEC) for use specifically as a tool in the development of engine control strategies.

The strategy operates by defining the ignition advance and fuel injector pulse length given engine speed rev/s and manifold absolute pressure (MAP). Several temperature inputs (ambient, inlet manifold, and coolant) are used to modify certain derived variables in the strategy during warm up periods. Further details of the system hardware configuration and control strategies for fuelling and ignition are presented in Figures 1 to 6.

The control strategy structure is fixed, but is tunable by ten maps (of 10 by 10 elements). The elements of these maps may be individually edited. Permanent or temporary offsets may also be added to every element of the specified map.

The state of MEC can be constantly displayed on a Lear Seagler ADM 5 or ADM 11 terminal. A trace of input and output variables may also be stored in volatile memory, and subsequently retrieved for display. The required changes to maps are also made via the terminal.

Since the original manual (DP84/1193) was written the details of the use of the "X MAP" have changed and EGR control has been added. This revision of the manual relates to the MEC software revision 2.8.3.

2. MAP ACCESS

The 10 by 10 maps are accessed by using the two input values as indexes (after normalisation), such that a block of four map values are identified as surrounding the true 'map operating point'. The map output is then computed by linear interpolation within this block.

The temperature compensation coefficients in the X map are also linearly interpolated between adjacent defined values.

3. MAP UNITS

Map Name	Select Character	Horizontal Axis para,units,range	Vertical Axis para,units,range	Map Output para, units
Steady State Fuel	F	rev/s,-, 20-100	MAP, mbar 100-1000	Fuel Inj. Fuel/100 arbitrary unit
Idle Fuel	G	rev/s,-, 2-20	MAP, mbar 100-1000	Fuel/Inj. Fuel/100 arbitrary unit
Exp. Impulse Height	H	rev/s,-, 20-100	Fuel/Inj, 5-50	Trans. height, % of SS fuel
Idle WW height	W	rev/s,-, 2-20	Fuel/Inj, 5-50	Trans. height % of SS fuel
Exp. Impulse Time Constant	C	rev/s,-, 10-100	Fuel/Inj, 5-50	Trans. time constant, mS
Throttle Angle Derivative	K	rev/s,-, 10-100	MAP, mbar 100-1000	Derivative coef, arbitrary unit
Advance Table	I	rev/s,-, 20-100	MAP, mbar 100-1000	Ign. advance, deg BTDC/100
Idle Ignition Map	J	rev/s,-, 2-20	MAP, mbar 100-1000	Ign. advance, deg BTDC/100
EGR valve	E	rev/s,-, 20-100	MAP, mbar 100-1000	0-1000 EGR, arbitrary unit.

In order to ensure that the EGR valve is fully closed when no EGR is required the scaling of the control voltage from MEC has been set so that the valve begins to open at a control value of approximately 230. The valve is fully open at a value of approximately 950. The EGR control system as described in more detail in ref 1.

To keep the operator informed of the state of the EGR control two values have been added to the display of engine parameters.

"EGR = xxxx" This is the current value calculated from the EGR map.

"EGRPOS = xxxx" This is a value calculated from the position of the EGR valve as measured by the position potentiometer. This is on a scale of

0 to 1000 corresponding to fully closed to fully open, respectively.

3.1 X MAP

There are five temperature compensation tables explicitly referred to. Each consists of 10 values which scale the control value and 10 temperatures used to determine the selection of the scaling value from the line above. The tables are for steady state fuelling compensation factors controlled by coolant temperature, two transient fuelling compensation controlled by the manifold charge temperature, and EGR compensation controlled by coolant temperature.

These tables are expressed as subsets of a 10 by 10 map (the X map) and therefore may be edited using the same mechanisms as the standard 10 by 10 maps. The format of these tables in the X map is shown below:

C	C	C	C	C	C	C	C	C	C	Transient time constant.	%
T	T	T	T	T	T	T	T	T	T	Manifold charge temp.	K
C	C	C	C	C	C	C	C	C	C	Transient height coef.	%
T	T	T	T	T	T	T	T	T	T	Manifold charge temp.	K
C	C	C	C	C	C	C	C	C	C	Steady state fuelling	%
T	T	T	T	T	T	T	T	T	T	Coolant temp.	K
100	100	100	100	100	100	100	100	100	100	(These fields must be	
100	100	100	100	100	100	100	100	100	100	set to 100)	
C	C	C	C	C	C	C	C	C	C	EGR	%
T	T	T	T	T	T	T	T	T	T	Coolant temp.	K

The C fields above are % values, thus to leave a parameter unmodified, a value of 100 must be selected. The corresponding T fields are temperature values expressed in degrees Kelvin and can be arbitrarily distributed throughout the temperature range of interest.

4. TERMINAL INTERACTION

On power-up MEC writes a heading at the top of the screen and then writes several lines of variable names together with their current values. These values are only updated when the engine is running, consequently at power-up the values have no significance.

The final line of this display field prompts for a character to be entered.

5. MAP EDITING

If the character is one corresponding to a map (as defined previously) then the corresponding map will be displayed, together with a prompt for map modification. Entering 'Y' will then result in a prompt for one of three modification methods, any other character will cause resumption of the continuous display of variables.

5.1 Table Update (T)

Entering a T will cause a prompt for a numerical value (of the format indicated by the prompt message); this number is then added to every detail of the internally held version of the displayed map, and the continuous display update is resumed.

5.2 Increment (I)

Entering an I will cause a prompt for either a 'U' (up) or 'D' (down character to be entered. The current number of increments/decrements is displayed. This 'inducing' facility can only be used in conjunction with the fuelling maps (F, G) and the ignition maps (I, J). In the case of the fuelling maps, a single integer (increment/decrement) causes a change in fuelling of 0.1, and in the case of those ignition maps a change in advance angle of 1 degree.

5.3 Single Change (S)

Entering an S allows the editing of individual map elements (the cursor is initially placed at the top left hand corner of the map). Use of the four 'arrow' keys moves the cursor around the map. To update a value type the number according to the format shown in the prompt. This format consists of five characters. The first is a "+", "-", or a space. The next four are numbers. A variation on this format occurs on the fuel maps where an "O" for the first character selects overrun (OVRUN) and gives no fuel. Typing an R terminates the editing session.

6. VARYING END OF INJECTION TIMING (EOI)

This function is selected by entering the character 'V'. The MEC will then request an EOI angle. This must be given in the range of ± 360 degrees.

The given value defines the end of injection. However the hardware cannot allow injection to continue through the 70^{o}BTDC reference. If this will cause a problem with the given EOI and fuel quantity then injection is commenced at the 70 degree mark. EOI will then vary with the fuel quantity. In either case the EOI is displayed on the engine panel on the MEC screen. It can also be "traced" for detailed analysis. The defined EOI value is part of the set of maps and will be saved and recalled along with these.

There is no provision for variation of EOI during transients in the current software.

7. MAP STORAGE AND RECALL

Whilst the display is being continuously updated (and prompting for a key press), other characters can be entered which perform loading and saving operations with the non-volatile memory (NVM). On power-up, maps from NVM1 or NVM2 are used. This is selection is determined by the position of the map select switch when the MEC is switched on. Subsequent moving of the switch has no effect. Maps from NVM 1-6 can be loaded by entering R (Recall) and following the ensuing prompt a number in the range 1 to 6. Similarly the current set of maps (all ten) can be saved into any of the six NVMs by entering S (Store) and the required number (following the prompt). Storage of the maps takes 40 seconds. During this time the engine is not controlled and should therefore be shut down. As an operational procedure, it is advisable to keep a back up of the current set of maps in more than one NVM.

8. TRACE MEMORY

A trace facility is provided for diagnostic purposes. Trace formatting and trace display are achieved by entering '!' (Shift 1) which clears the screen and causes a prompt for further characters. Entering 'A' will abort a trace in progress, 'T' will start a trace. 'F' displays the available format option and allows assignment of variables for trace and analogue channels simply by entering the appropriate variable character. Up and down arrows allow the cursor to be moved up and down the format field.

Up to ten variables, from a pre-defined set, may be stored, every occasion control of the engine is invoked. Memory capacity is such that up to 800 cycles may be retained, the oldest cycles are continually rejected until entering 'A'. Up to four of the variables may be output onto analogue channels, with the facility to determine the gain of individual channels.

In order to display the contents of the trace memory enter 'D', which displays the oldest page of data. Entering 'E' whilst in this mode displays the end of the trace (newest data). Entering either '-' or '+' space causes adjacent pages of information to be displayed.

The values of the variables displayed in the trace display are in internal units without decimal point information being displayed.

The analogue channel gains require a four digit decimal number. Entering 0100 sets the output to unity gain. To terminate the format session enter 'ESC'.

9. VISUAL DISPLAY TERMINAL

The MEC is programmed to use a Lear Siegler ADM 11 Visual Display

Terminal (VDT). This has a number of internal settings. These should be as follows :

CLICK	NO	HDX/FDX	FDX
ONLINE	YES	CHR/FNC	8
CURSOR	NO	FNC/NVM	NO
STATUS	BLANK	SO/SI	GT EX
WRAP	NO	HZ	50
NEWLINE	NO	HNDSHK	DTR
BPS	9600	XON/XOFF	DC1/DC3
BITS	7	BUSY	LO
BIT8	1	ANSBK	NO
PTY?	YES	SCRNSAVE	YES
PTY	EVEN		

10. REFERENCES

1 Incorporation of Exhaust Gas Recirculation (EGR) Control in the Micro Processor Engine Controller (MEC). DP85/1466

RICARDO

FIG. No. 1
Drg. No. 511923
Date APRIL '86

MICROPROCESSOR ENGINE CONTROLLER

HARDWARE

MICROPROCESSOR	-	TMS9995 - 16 BIT INTERNAL DATA BUS
RAM	-	32K
PROM	-	32K
EEPROM	-	12K (STORES 6 MAP SETS)
A/D	-	UP TO 16 CHANNELS, 12 BIT RESOLUTION
D/A	-	4 CHANNELS, 12 BITS
MAP INPUT	-	DIGITAL INTEGRATOR PROVIDES MEAN MAP OVER ½ REV
TIMING CONTROLLER	-	MEASURES SPEED
	-	PROVIDES INJECTION PULSE OF DEFINABLE DURATION AND DELAY
	-	PROVIDES IGNITION PULSE OF DEFINABLE ADVANCE AND DWELL
INJECTOR DRIVERS	-	DIRECT DRIVE OF FUEL INJECTORS
IGNITION DRIVER	-	OPTO - ISOLATED OUTPUT FOR DIRECT DRIVE OF PROPRIETARY ELECTRONIC IGNITION UNIT

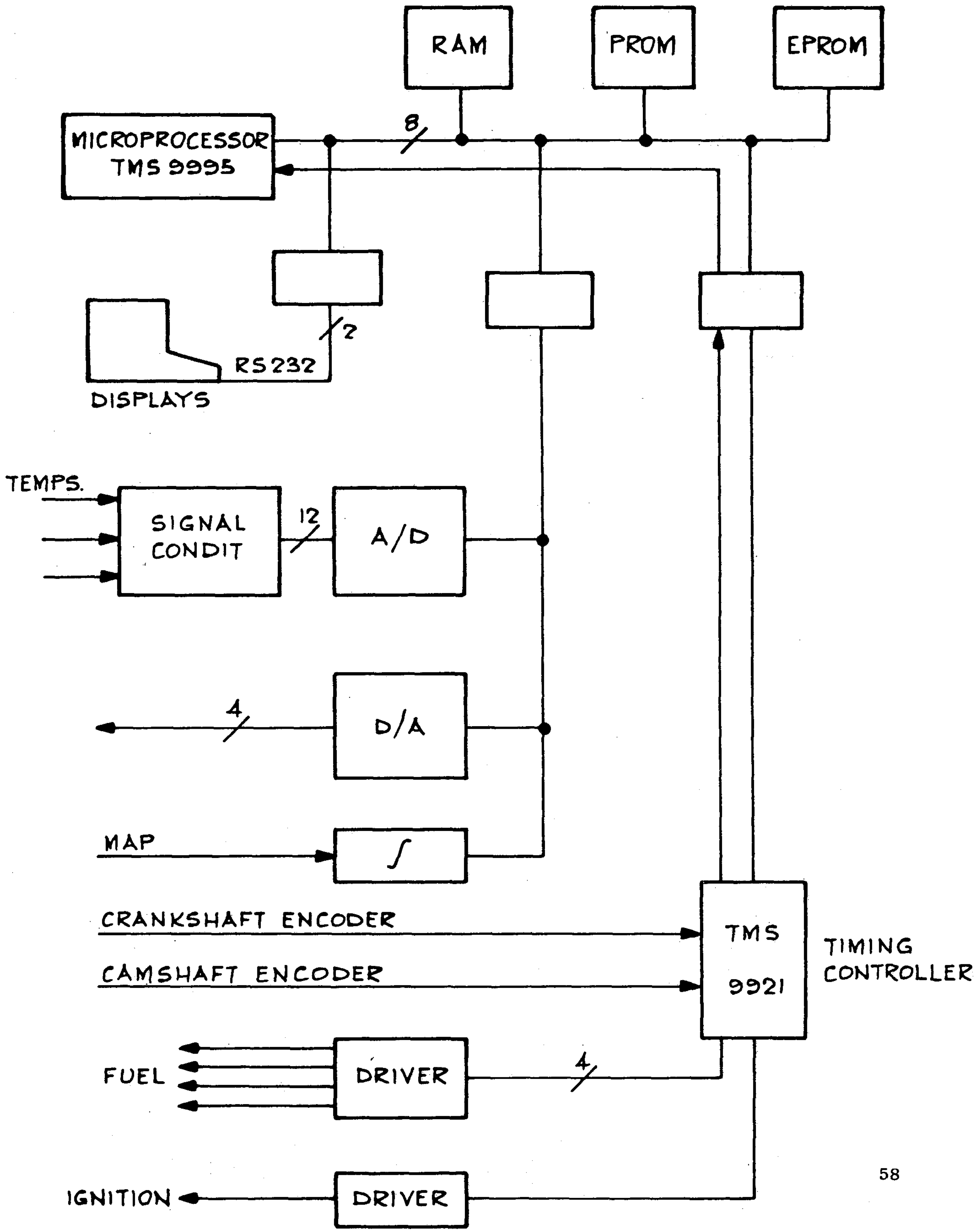
RICARDO

FIG. No. 2

Drg. No.

Date MAY '86

RICARDO MICROPROCESSOR ENGINE CONTROLLER



IPM LTD. 6448MT

RICARDO

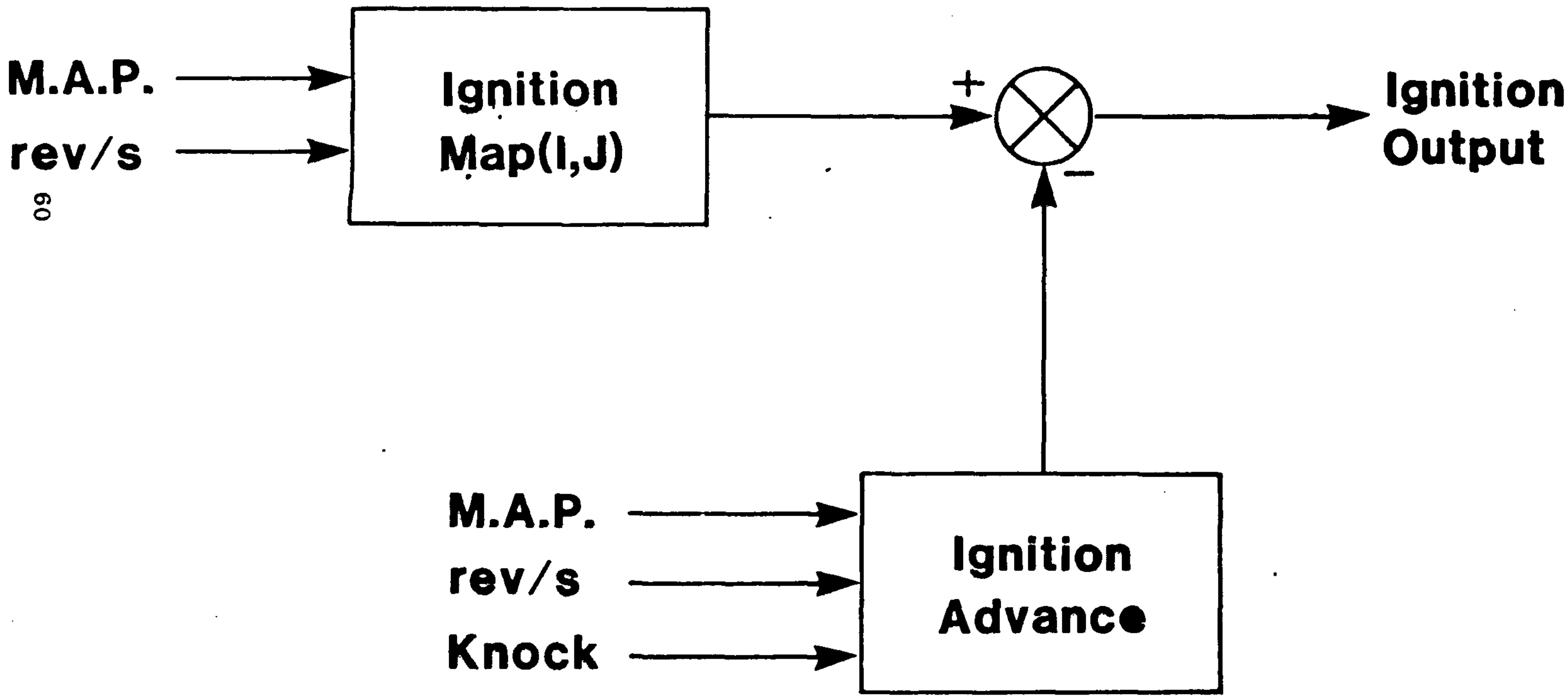
FIG. No. 3
Drg. No. 511524
Date APRIL '86

SOFTWARE

* DATA ACQUISITION
* COMPUTATION
* TIMING AND CONTROL

CONTROL TASKS	-	INVOKED EVERY ½ REV
	-	MODULAR CODE (SIMPLIFIES MODIFICATION, ADAPTATION AND MAINTENANCE)
	-	ASSEMBLER CODED FOR HIGH PERFORMANCE
OPERATOR INTERFACE	-	DISPLAYS ACQUIRED AND COMPUTED PARAMETERS
	-	ALLOWS INTERACTIVE MAP EDITING
	-	DATA LOGGING CONTROL
	-	ALLOWS 10 OF 30 PARAMETERS TO BE CHOSEN
	-	LOGS APPROXIMATELY 1000 SETS OF DATA
	-	CONTROL OF LOGGING DISPLAY

RICARDO M.E.C. IGNITION STRATEGY



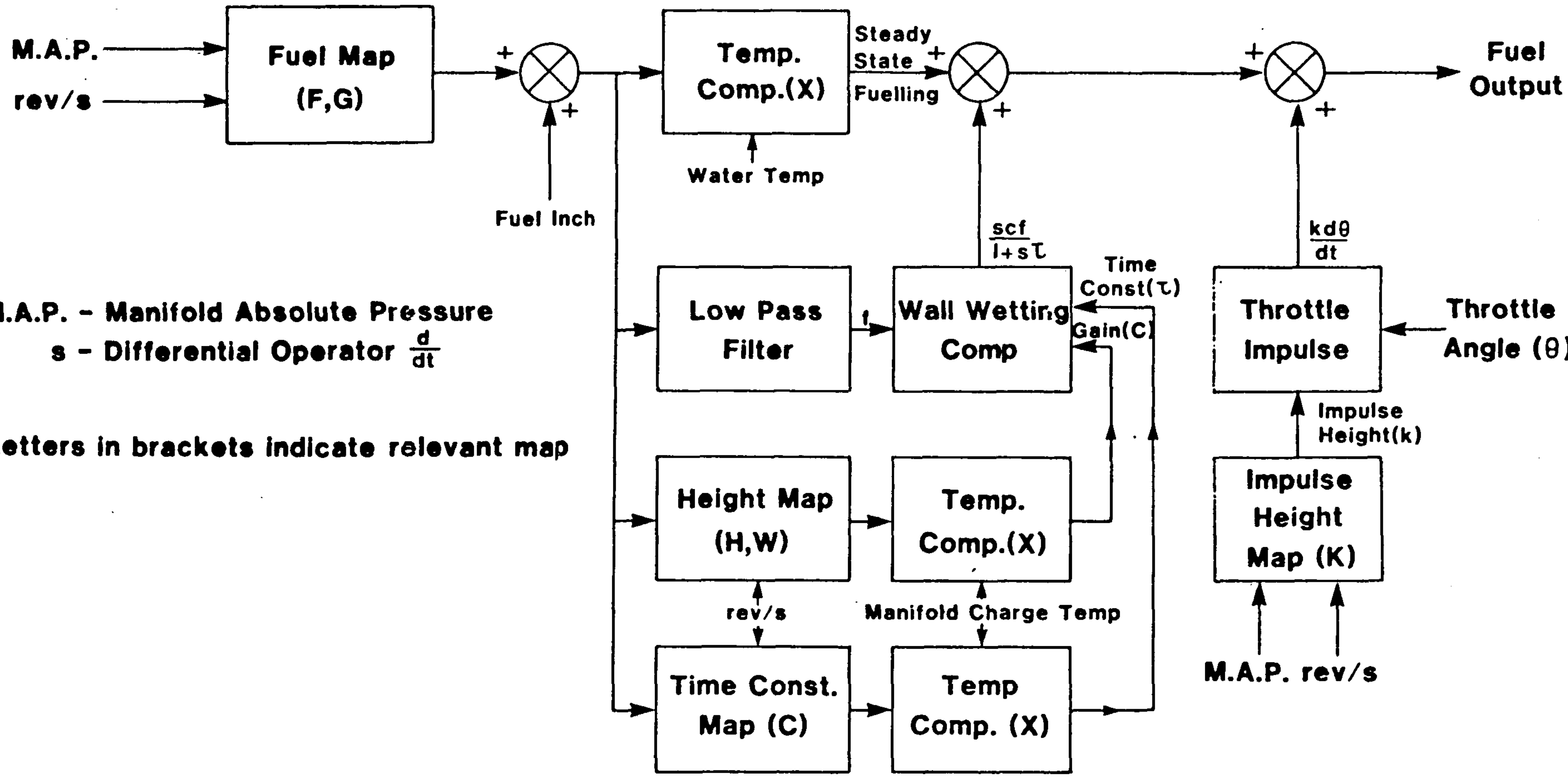
M.A.P. - Manifold Absolute Pressure

Letters in brackets indicate relevant maps

FIG. No. 4
Drg. No. 911725
Date APRIL '86

RICARDO

RICARDO M.E.C. FUELLING STRATEGY



M.A.P. - Manifold Absolute Pressure

s - Differential Operator $\frac{d}{dt}$

Letters in brackets indicate relevant map

FIG. No. 5

Drg. No. 51192G

Date APRIL '86

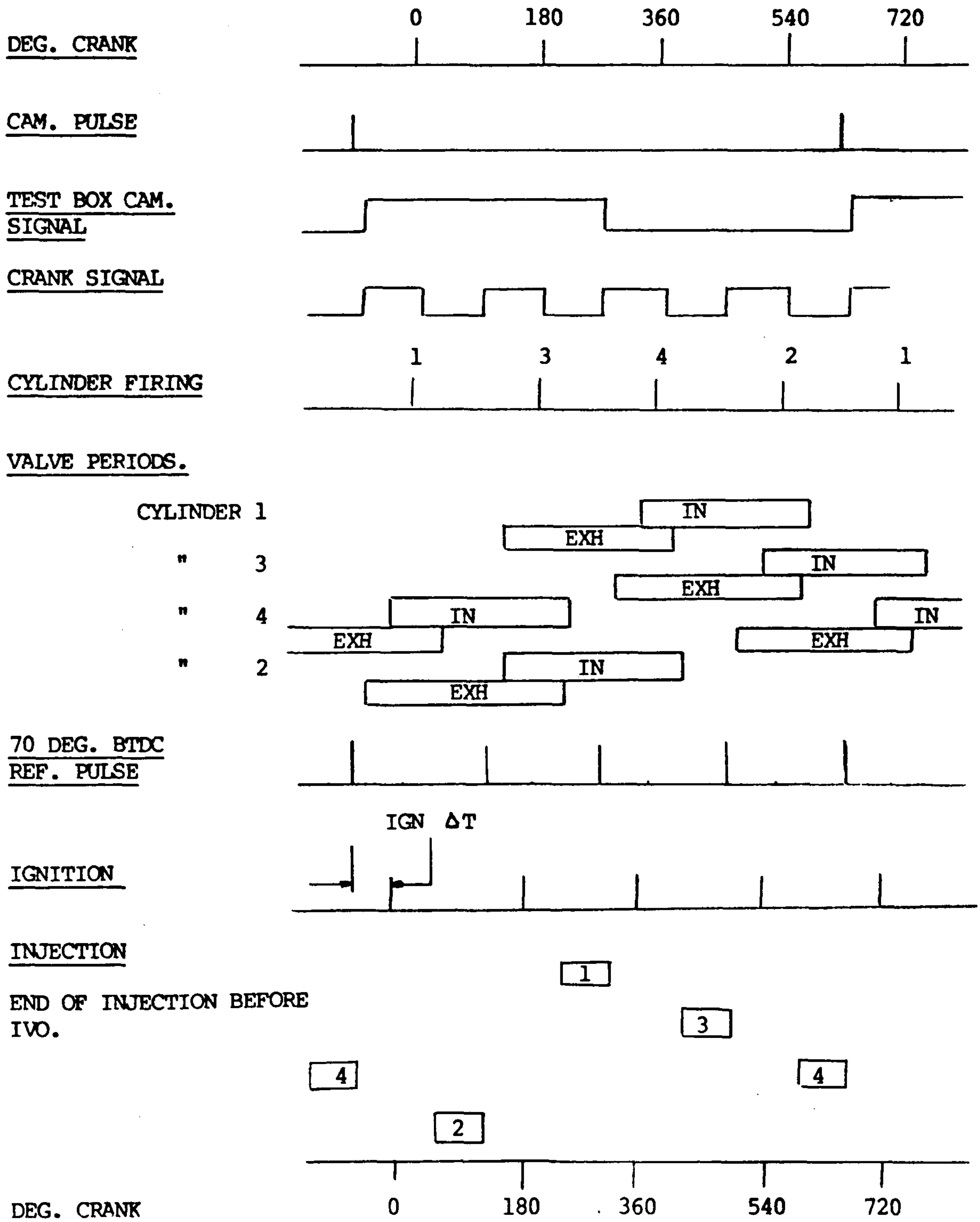
RICARDO

FIG. No. 6

Drg. No. 511527

Date APRIL '86

MEC SEQUENCE OF EVENTS



APPENDIX III

MEC-BEST ECONOMY STRATEGY MAPS

EEPROM BEST ECONOMY/OPT IGN.FEB 1986

H.A.- RPS(*10), V.A.- FUEL(*5) << Exp. Impulse Time Constant(mS) - "C" >

	1	2	3	4	5	6	7	8	9	10
10	0080	0030	0035	0030	0030	0050	0050	0050	0050	0050
9	0090	0030	0030	0040	0035	0050	0050	0050	0050	0050
8	0100	0035	0035	0050	0035	0050	0050	0050	0050	0050
7	0110	0040	0040	0055	0040	0050	0050	0050	0050	0050
6	0120	0045	0045	0055	0040	0050	0050	0050	0050	0050
5	0130	0050	0050	0060	0045	0050	0050	0050	0050	0050
4	0140	0055	0055	0060	0045	0050	0050	0050	0050	0050
3	0150	0060	0060	0065	0050	0050	0050	0050	0050	0050
2	0150	0060	0060	0065	0050	0050	0050	0050	0050	0050
1	0150	0060	0060	0065	0050	0050	0050	0050	0050	0050

H.A.- RPS(*10), V.A.- MAP(mB*100) << Throttle Angle Derivative - "K" >>

	1	2	3	4	5	6	7	8	9	10
10	0000	0140	0200	0200	0200	0200	0200	0200	0200	0200
9	0000	0160	0310	0280	0150	0200	0200	0200	0200	0200
8	0000	0180	0330	0300	0170	0200	0200	0200	0200	0200
7	0000	0200	0340	0320	0210	0200	0200	0200	0200	0200
6	0000	0220	0350	0340	0240	0200	0200	0200	0200	0200
5	0000	0240	0375	0360	0260	0200	0200	0200	0200	0200
4	0000	0270	0400	0380	0280	0200	0000	0200	0200	0200
3	0000	0300	0450	0400	0300	0200	0200	0200	0200	0200
2	0000	0300	0450	0400	0300	0200	0200	0200	0200	0200
1	0000	0300	0450	0400	0300	0200	0200	0200	0200	0200

H.A.- RPS(*10), V.A.- MAP(mB*100)<< Advance Table(deg/100 BTDC) - "I" >>

	1	2	3	4	5	6	7	8	9	10
10	0500	0500	0900	1300	1400	1500	1600	1700	1700	1800
9	0500	1600	1700	1900	2000	2200	2200	2200	2200	2200
8	0500	1900	2000	2100	2200	2300	2400	2600	2600	2600
7	0600	2100	2100	2200	2300	2400	2600	2700	2700	2700
6	0000	2300	2300	2300	2300	2500	2600	2700	2700	2700
5	0600	2300	2300	2300	2300	2500	2600	2700	2700	2800
4	0600	2300	2300	2300	2400	2500	2600	2700	2700	2800
3	0600	2300	2300	2300	2400	2500	2600	2700	2700	2800
2	0600	2300	2300	2300	2400	2500	2600	2700	2700	2800
1	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000

H.A.- RPS(*2), V.A.- MAP(mB*100) < Idle Ign. Map - "J" (deg/100 BTDC) >

	1	2	3	4	5	6	7	8	9	10
10	0000	0000	0000	0000	0000	0500	0500	0500	0500	0500
9	0000	0000	0000	0000	0000	0500	0500	0800	1000	1600
8	0000	0000	0000	0000	0000	0500	0700	1000	1400	1900
7	0000	0000	0000	0000	0000	0600	0800	1200	1600	2100
6	0000	0000	0000	0400	0600	0600	0800	1200	1700	2300
5	0000	0000	0000	0400	0600	0600	0800	1400	1800	2300
4	0000	0000	0000	0400	0600	0600	0800	1600	2000	2300
3	0000	0000	0000	0400	0600	0600	0800	1600	2000	2300
2	0000	0000	0000	0400	0600	0600	0800	1300	1600	2000
1	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000

EEPROM BEST ECONOMY/OPT IGN.FEB 1986 recalled

H.A.- RPS(*10), V.A.- MAP(mB*100)<< Fuel Injection Table(Fuel/100) - "F" >>

	1	2	3	4	5	6	7	8	9	10
10	0000	4100	4600	4950	5350	5450	5700	5900	6100	6300
9	0000	2380	2575	2710	2800	2815	2930	2990	3050	3100
8	0000	2130	2275	2395	2470	2480	2590	2650	2700	2750
7	0000	1850	1980	2080	2125	2165	2240	2305	2380	2450
6	0000	1580	1690	1770	1830	1840	1950	1970	2020	2100
5	0000	1350	1420	1470	1520	1530	1640	1640	1670	1700
4	0000	1100	1160	1170	1220	1220	1320	1320	1350	1400
3	0000	0900	0915	0930	0970	1010	1050	1200	OVRUN	OVRUN
2	0000	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN
1	0000	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN

H.A.- RPS(*2), V.A.- MAP(mB*100) < Idle Fuel Map - "G" (Fuel/100) >

	1	2	3	4	5	6	7	8	9	10
10	6000	6000	6000	6000	6000	6000	6000	6000	6000	4100
9	4500	4500	4500	4500	4400	4200	4000	4000	4000	2380
8	4200	4200	4200	4000	3700	3400	3200	3200	3200	2130
7	3800	3800	3800	3500	3200	3000	2600	2600	2600	1850
6	3000	3000	3000	2700	2400	2100	2000	2000	2000	1580
5	2600	2600	2400	2200	2000	1700	1700	1600	1600	1350
4	2000	1900	1800	1600	1600	1480	1370	1280	1250	1100
3	OVRUN	OVRUN	1500	1400	1300	1200	1020	0950	0900	0900
2	OVRUN	OVRUN	1800	1600	1500	1200	1200	1200	1200	1200
1	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN

H.A.- RPS(*10), V.A.- FUEL(*5) << Exp. Impulse Height(%) - "H" >>

	1	2	3	4	5	6	7	8	9	10
10	0000	0030	0030	0030	0030	0030	0030	0030	0030	0030
9	0000	0050	0040	0040	0045	0030	0030	0030	0030	0030
8	0000	0070	0045	0050	0060	0030	0030	0030	0030	0030
7	0000	0080	0050	0055	0070	0030	0030	0030	0030	0030
6	0000	0090	0060	0060	0080	0030	0030	0030	0030	0030
5	0000	0100	0070	0065	0085	0030	0030	0030	0030	0030
4	0000	0110	0080	0075	0090	0030	0030	0030	0030	0030
3	0000	0120	0090	0080	0100	0030	0030	0030	0030	0030
2	0000	0120	0090	0080	0100	0030	0030	0030	0030	0030
1	0000	0120	0090	0080	0100	0030	0030	0030	0030	0030

H.A.- RPS(*2), V.A.- MAP(mB*100) << WW Idle Height - "W" >>

	1	2	3	4	5	6	7	8	9	10
10	0000	0000	0000	0000	0000	0000	0060	0060	0060	0060
9	0000	0000	0000	0000	0000	0000	0060	0060	0060	0060
8	0000	0000	0000	0000	0000	0000	0080	0060	0060	0060
7	0000	0000	0000	0000	0000	0000	0080	0080	0060	0060
6	0000	0000	0000	0000	0000	0000	0100	0100	0060	0060
5	0000	0000	0000	0000	0000	0000	0120	0120	0120	0120
4	0000	0000	0000	0000	0000	0000	0140	0140	0120	0125
3	0000	0000	0000	0000	0000	0000	0160	0160	0120	0125
2	0000	0000	0000	0000	0000	0000	0160	0160	0120	0125
1	0000	0000	0000	0000	0000	0000	0000	0080	0060	0060

EEPROM BEST ECONOMY/OPT IGN.FEB 1986 recalled
H.A.- RPS(*10), V.A.- MAP(mB*100) < E.G.R. 0 to 1000 >

	1	2	3	4	5	6	7	8	9	10
10	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
9	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
8	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
7	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
6	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
5	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
4	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
3	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
2	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
1	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000

5 Two Line Temp. Comp. Tables (COMP./TEMP.), TEMP(KELVIN), COMP(%)

	1	2	3	4	5	6	7	8	9	10
10	0200	0200	0200	0200	0200	0180	0160	0140	0100	0100
9	0270	0280	0290	0295	0300	0305	0310	0317	0323	0328
8	0200	0200	0200	0200	0200	0180	0160	0140	0100	0100
7	0270	0280	0290	0295	0300	0305	0310	0317	0323	0328
6	0350	0250	0200	0160	0140	0125	0115	0110	0100	0100
5	0270	0280	0285	0290	0295	0305	0310	0320	0330	0340
4	0100	0100	0100	0100	0100	0100	0100	0100	0100	0100
3	0100	0100	0100	0100	0100	0100	0100	0100	0100	0100
2	0000	0000	0000	0000	0000	0000	0020	0040	0070	0100
1	0270	0280	0285	0290	0295	0305	0310	0320	0330	0340

APPENDIX IV

MEC-REDUCED NOx STRATEGY MAPS

EEPROM REDUCED NOX STRATEGY JUNE 86

H.A.- RPS(*10), V.A.- MAP(mB*100)<< Fuel Injection Table(Fuel/100) - "F" >>

10	0000	4100	4600	4950	5350	5450	5700	5900	6100	6300
9	0000	2660	2750	2820	2930	3030	3900	5000	5400	5700
8	0000	2170	2250	2280	2340	2365	2700	2970	3000	3050
7	0000	1830	1900	1960	1980	2000	2280	2550	2620	2650
6	0000	1540	1690	1750	1800	1820	2000	2200	2240	2300
5	0000	1300	1420	1470	1500	1510	1670	1820	1850	1900
4	0000	1210	1190	1175	1250	1290	1360	1470	1490	1520
3	0000	0900	0915	0920	1000	1080	1100	1200	OVRUN	OVRUN
2	0000	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN
1	0000	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN
	1	2	3	4	5	6	7	8	9	10

H.A.- RPS(*2), V.A.- MAP(mB*100) < Idle Fuel Map - "G" (Fuel/100) >

10	6000	6000	6000	6000	6000	6000	6000	6000	6000	4100
9	4500	4500	4500	4500	4400	4200	4000	4000	4000	2600
8	4200	4200	4200	4000	3700	3400	3200	3200	3200	2170
7	3800	3800	3800	3500	3200	3000	2600	2600	2600	1830
6	3000	3000	3000	2700	2400	2100	2000	2000	2000	1540
5	2600	2600	2400	2200	2000	1700	1700	1600	1600	1300
4	2000	1900	1800	1600	1600	1480	1370	1280	1250	1210
3	OVRUN	OVRUN	1500	1400	1300	1200	1020	0950	0900	0900
2	OVRUN	OVRUN	1800	1600	1500	1200	1200	1200	1200	1200
1	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN	OVRUN
	1	2	3	4	5	6	7	8	9	10

H.A.- RPS(*10), V.A.- FUEL(*5) << Exp. Impulse Height(%) - "H" >>

10	0110	0110	0020	0040	0020	0030	0030	0030	0030	0030
9	0110	0110	0030	0040	0020	0030	0030	0030	0030	0030
8	0120	0120	0030	0045	0025	0030	0030	0030	0030	0030
7	0120	0120	0030	0045	0025	0030	0030	0030	0030	0030
6	0130	0130	0030	0050	0030	0030	0030	0030	0030	0030
5	0140	0140	0050	0050	0030	0030	0030	0030	0030	0030
4	0140	0140	0060	0055	0035	0030	0030	0030	0030	0030
3	0150	0150	0060	0055	0035	0030	0030	0030	0030	0030
2	0150	0150	0060	0060	0040	0030	0030	0030	0030	0030
1	0150	0150	0060	0060	0040	0030	0030	0030	0030	0030
	1	2	3	4	5	6	7	8	9	10

H.A.- RPS(*2), V.A.- MAP(mB*100) << WW Idle Height - "W" >>

10	0000	0000	0000	0000	0000	0000	0060	0060	0060	0060
9	0000	0000	0000	0000	0000	0000	0060	0060	0060	0060
8	0000	0000	0000	0000	0000	0000	0080	0060	0060	0060
7	0000	0000	0000	0000	0000	0000	0080	0080	0060	0060
6	0000	0000	0000	0000	0000	0000	0100	0100	0060	0060
5	0000	0000	0000	0000	0000	0000	0120	0120	0120	0120
4	0000	0000	0000	0000	0000	0000	0140	0140	0120	0125
3	0000	0000	0000	0000	0000	0000	0160	0160	0120	0130
2	0000	0000	0000	0000	0000	0000	0160	0160	0120	0130
1	0000	0000	0000	0000	0000	0000	0000	0080	0060	0060
	1	2	3	4	5	6	7	8	9	10

EEPROM REDUCED NOX STRATEGY JUNE 86 recalled

H.A.- RPS(*10), V.A.- FUEL(*5) << Exp. Impulse Time Constant(mS) - "C" >

	1	2	3	4	5	6	7	8	9	10
10	0035	0030	0085	0050	0080	0150	0150	0150	0150	0150
9	0040	0035	0090	0055	0090	0150	0150	0150	0150	0150
8	0045	0035	0095	0060	0100	0150	0150	0150	0150	0150
7	0050	0040	0100	0065	0110	0150	0150	0150	0150	0150
6	0055	0040	0105	0070	0120	0150	0150	0150	0150	0150
5	0060	0045	0110	0075	0130	0150	0150	0150	0150	0150
4	0065	0045	0115	0075	0140	0150	0150	0150	0150	0150
3	0070	0050	0120	0080	0150	0150	0150	0150	0150	0150
2	0070	0050	0120	0080	0150	0150	0150	0150	0150	0150
1	0070	0050	0120	0080	0150	0150	0150	0150	0150	0150

H.A.- RPS(*10), V.A.- MAP(mB*100) << Throttle Angle Derivative - "K" >>

	1	2	3	4	5	6	7	8	9	10
10	0000	0220	0120	0260	0320	0300	0300	0300	0300	0300
9	0330	0230	0130	0280	0330	0300	0300	0300	0300	0300
8	0340	0240	0140	0290	0340	0300	0300	0300	0300	0300
7	0350	0250	0150	0300	0350	0300	0300	0300	0300	0300
6	0360	0260	0160	0310	0360	0300	0300	0300	0300	0300
5	0370	0270	0170	0320	0370	0300	0300	0300	0300	0300
4	0380	0280	0180	0330	0380	0300	0300	0300	0300	0300
3	0390	0290	0190	0340	0390	0300	0300	0300	0300	0300
2	0400	0300	0200	0350	0400	0300	0300	0300	0300	0300
1	0400	0300	0200	0350	0400	0300	0300	0300	0300	0300

H.A.- RPS(*10), V.A.- MAP(mB*100)<< Advance Table(deg/100 BTDC) - "I" >>

	1	2	3	4	5	6	7	8	9	10
10	0000	0500	0700	0800	0900	1000	1600	1700	1700	1800
9	0000	0700	0900	1000	1000	1000	2100	2100	2100	2100
8	0000	1000	1200	1200	1200	1200	2200	2300	2400	2400
7	0000	2000	2100	2100	2200	2300	2400	2500	2500	2500
6	0000	2100	2100	2100	2200	2400	2400	2500	2500	2500
5	0000	2100	2100	2100	2200	2400	2400	2500	2500	2600
4	0000	2100	2100	2100	2200	2400	2400	2500	2500	2600
3	0000	2100	2100	2100	2200	2400	2400	2500	2500	2600
2	0000	2000	2100	2100	2200	2400	2400	2500	2500	2600
1	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000

H.A.- RPS(*2), V.A.- MAP(mB*100) < Idle Ign. Map - "J" (deg/100 BTDC) >

	1	2	3	4	5	6	7	8	9	10
10	0000	0000	0000	0000	0000	0500	0500	0500	0500	0500
9	0000	0000	0000	0000	0000	0500	0500	0800	1000	1600
8	0000	0000	0000	0000	0000	0500	0700	1000	1400	1900
7	0000	0000	0000	0000	0000	0600	0700	1200	1600	2100
6	0000	0000	0000	0400	0600	0600	0800	1200	1700	2100
5	0000	0000	0000	0400	0600	0600	0800	1400	1800	2100
4	0000	0000	0000	0400	0600	0600	0800	1600	2000	2100
3	0000	0000	0000	0400	0600	0600	0800	1600	2000	2100
2	0000	0000	0000	0400	0600	0600	0800	1300	1600	2000
1	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000

EEPROM REDUCED NOX STRATEGY JUNE 86 recalled
H.A.- RPS(*10), V.A.- MAP(mB*100) < E.G.R. 0 to 1000 >

	1	2	3	4	5	6	7	8	9	10
10	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
9	0000	0240	0350	0450	0500	0550	0420	0000	0000	0000
8	0000	0250	0350	0430	0475	0500	0400	0000	0000	0000
7	0000	0260	0370	0440	0550	0650	0550	0000	0000	0000
6	0000	0240	0330	0400	0470	0560	0440	0000	0000	0000
5	0000	0220	0280	0320	0350	0370	0330	0000	0000	0000
4	0000	0200	0230	0230	0240	0260	0240	0000	0000	0000
3	0000	0000	0225	0225	0225	0000	0000	0000	0000	0000
2	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
1	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000

5 Two Line Temp. Comp. Tables (COMP./TEMP.), TEMP(KELVIN), COMP(%)

	1	2	3	4	5	6	7	8	9	10
10	0200	0200	0200	0200	0200	0180	0160	0140	0100	0100
9	0270	0280	0290	0295	0300	0305	0310	0317	0323	0328
8	0200	0200	0200	0200	0200	0180	0160	0140	0100	0100
7	0270	0280	0290	0295	0300	0305	0310	0317	0323	0328
6	0350	0250	0200	0160	0140	0125	0115	0110	0100	0100
5	0270	0280	0285	0290	0295	0305	0310	0320	0330	0340
4	0100	0100	0100	0100	0100	0100	0100	0100	0100	0100
3	0100	0100	0100	0100	0100	0100	0100	0100	0100	0100
2	0000	0000	0000	0000	0000	0000	0020	0040	0070	0100
1	0270	0280	0285	0290	0295	0305	0310	0320	0330	0340

RICARDO
CONSULTING ENGINEERS

APPENDIX V

TABULATED TEST RESULTS

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

INITIAL TESTS WITH DISTRIBUTOR IGNITION

MIXTURE LOOP AT 40 REV/SEC 2.5 BAR BMEP (2ND REPEAT)

REFER TO FIGURE NOS. 5-8

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
19	3	85	3.00	759.40	10.00	15.50	0	0.	4

1 ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00	40.00	40.00
28 IGNITION TIMING	12.00	17.00	19.50	21.00	26.50	36.00
4 FUEL VOLUME (CC)	102.50	102.50	102.50	102.50	102.50	102.50
2 BRAKE LOAD	29.00	29.00	29.00	29.00	29.00	29.00
5 FUEL TIME (SEC)	44.15	48.05	50.05	51.35	51.55	49.95
6 FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00	12.00	12.00
8 AIR METER TEMPERATURE (C)	16.00	17.00	17.00	17.00	17.00	17.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-421.87	-418.86	-401.57	-375.25	-343.66	-285.76
26 EXHAUST TEMP. (POST TURBO)	406.0	412.0	407.0	396.0	391.0	373.0
27 EXHAUST PRESSURE (POST TURBO)	8.3	9.0	10.5	12.0	14.3	18.8
13 CARBON MONOXIDE (%)	2.450	.550	.220	.158	.146	.214
15 CARBON DIOXIDE (%)	13.500	14.400	13.100	11.300	9.800	8.000
16 OXYGEN (%)	.150	.500	2.600	5.100	7.250	9.700
12 HYDROCARBONS (PPMC)	3300.0	2130.0	2040.0	2460.0	2880.0	4800.0
14 OXIDES OF NITROGEN (PPM)	320.0	810.0	800.0	330.0	120.0	50.0

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

INITIAL TESTS WITH DISTRIBUTOR IGNITION

REFER TO FIGURE NOS. 5-8

MIXTURE LOOP AT 40 REV/SEC 2.5 BAR BMEP (2ND REPEAT)

DATE 19/ 3/85 TEST NO. 3.0 BAROMETER 759.40 MM.HG WET BULB TEMP(C) 10.0
DRY BULB TEMP(C) 15.5

RELATIVE HUMIDITY = 48.66
HUMIDITY CORRECTION FACTOR = .84
GRAINS OF WATER/LB DRY AIR = 37.13

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	7.29	2.50	29.00	914.1	30.2(.0)	5.8(.0)	19.75	9.26	2.16	120.31	1041.62	11.42
40.0	7.29	2.50	29.00	839.9	30.6(.0)	6.4(.0)	21.49	5.90	5.39	26.64	1096.08	11.29
40.0	7.29	2.50	29.00	806.4	32.8(.0)	7.1(.0)	22.39	6.08	5.73	11.47	1073.30	11.81
40.0	7.29	2.50	29.00	786.0	36.5(.0)	8.1(.0)	22.97	8.26	2.66	9.28	1042.71	10.92
40.0	7.29	2.50	29.00	782.9	41.4(.0)	9.3(.0)	23.06	11.02	1.10	9.77	1030.18	12.12
40.0	7.29	2.50	29.00	808.0	49.9(.0)	10.8(.0)	22.34	22.30	.56	17.39	1021.63	22.86

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

INITIAL TESTS WITH EPA DISTRIBUTOR IGNITION

MIXTURE LOOP AT 60 REV/SEC 5.5 BAR BMEP

REFER TO FIGURE NOS. 9-12

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
19	3	85	4.00	757.79	13.00	19.50	0	0.	4

1	ENGINE SPEED (REV/S)	60.00	60.00	60.00	60.00	60.00	60.00
28	IGNITION TIMING	15.00	19.00	20.00	23.00	29.00	48.00
4	FUEL VOLUME (CC)	203.00	203.00	203.00	203.00	203.00	203.00
2	BRAKE LOAD	63.80	63.80	63.80	63.80	63.80	63.80
5	FUEL TIME (SEC)	36.55	39.70	41.30	41.85	42.20	40.75
6	FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00	12.00	12.00
8	AIR METER TEMPERATURE (C)	18.00	19.00	20.00	19.00	20.00	19.00
11	INTAKE MANIFOLD PRESS.(mm.Hg)	-275.23	-269.22	-236.13	-188.00	-127.09	-52.64
26	EXHAUST TEMP. (POST TURBO)	558.0	582.0	572.0	542.0	515.0	489.0
27	EXHAUST PRESSURE (POST TURBO)	44.4	46.6	51.1	57.9	69.2	86.5
13	CARBON MONOXIDE (%)	2.600	.520	.180	.144	.115	.166
15	CARBON DIOXIDE (%)	13.100	14.500	13.000	11.100	9.700	8.400
16	OXYGEN (%)	.200	.450	2.600	5.100	7.350	9.200
12	HYDROCARBONS (PPMC)	2040.0	1260.0	720.0	1050.0	1620.0	2760.0
14	OXIDES OF NITROGEN (PPM)	820.0	1700.0	1700.0	740.0	195.0	105.0

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

INITIAL TESTS WITH EPA DISTRIBUTOR IGNITION

MIXTURE LOOP AT 60 REV/SEC 5.5 BAR BMEP

REFER TO FIGURE NOS. 9-12

DATE 19/ 3/85 TEST NO. 4.0 BAROMETER 757.79 MM.HG WET BULB TEMP(C) 13.0
DRY BULB TEMP(C) 19.5

RELATIVE HUMIDITY = 46.77
HUMIDITY CORRECTION FACTOR = .88
GRAINS OF WATER/LB DRY AIR = 46.12

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
60.0	24.05	5.50	63.80	662.7	48.8(.0)	5.8(.0)	27.24	4.25	4.32	94.75	750.06	8.57
60.0	24.05	5.50	63.80	610.1	49.5(.0)	6.4(.0)	29.59	2.54	8.66	18.32	802.60	11.19
60.0	24.05	5.50	63.80	586.5	53.8(.0)	7.2(.0)	30.78	1.59	9.51	6.97	790.55	11.10
60.0	24.05	5.50	63.80	578.8	60.8(.0)	8.3(.0)	31.19	2.68	4.77	6.42	777.84	7.45
60.0	24.05	5.50	63.80	574.0	69.2(.0)	9.5(.0)	31.45	4.66	1.42	5.79	766.79	6.08
60.0	24.05	5.50	63.80	594.4	80.3(.0)	10.7(.0)	30.37	9.28	.89	9.76	775.92	10.17

EPA/VW HRCC METHANOL (79.5mm x 73.4mm)

INITIAL TESTS WITH EPA DISTRIBUTOR IGNITION

FULL LOAD POWER CURVE-LBT FUELLING/MBT IGN TIMING

REFER TO FIGURE NOS. 14-17

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
20	3	85	5.00	757.86	14.50	21.00	1	0.	1

1 ENGINE SPEED (REV/S)	20.00	30.00	40.00	50.00	60.00	70.00	80.00
28 IGNITION TIMING	10.00	14.00	16.00	16.00	17.00	18.00	18.00
4 FUEL VOLUME (CC)	203.00	203.00	304.00	304.00	507.00	507.00	507.00
2 BRAKE LOAD	100.10	110.80	117.90	130.30	126.40	104.00	82.90
5 FUEL TIME (SEC)	75.05	48.75	52.05	37.95	56.00	55.90	55.95
6 FUEL TEMPERATURE (C)	14.00	14.00	14.00	13.00	13.00	13.00	13.00
8 AIR METER TEMPERATURE (C)	14.00	14.00	14.00	15.00	17.00	18.00	18.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-1.50	-2.26	-3.01	-3.76	-4.51	-103.02	-193.26
26 EXHAUST TEMP. (POST TURBO)	389.0	467.0	540.0	593.0	626.0	631.0	636.0
27 EXHAUST PRESSURE (POST TURBO)	15.0	24.1	48.1	84.2	114.3	114.3	114.3
13 CARBON MONOXIDE (%)	2.200	2.300	2.500	2.600	2.100	2.400	2.700
15 CARBON DIOXIDE (%)	13.600	13.500	13.500	13.500	14.000	13.700	13.600
16 OXYGEN (%)	.250	.200	.200	.200	.300	.200	.200
12 HYDROCARBONS (PPMC)	5100.0	3600.0	3600.0	2910.0	1740.0	1140.0	780.0
14 OXIDES OF NITROGEN (PPM)	1300.0	1100.0	1100.0	1150.0	1350.0	1100.0	1000.0

EPA/VW HPCC METHANOL (79.5mm x 73.4mm)
INITIAL TESTS WITH EPA DISTRIBUTOR IGNITION
FULL LOAD POWER CURVE-LBT FUELLING,MBT IGN TIMING

REFER TO FIGURE NOS. 14-17

DATE 20/ 3/85 TEST NO. 5.0 BAROMETER 757.86 MM.HG WET BULB TEMP(C) 14.5 DRY BULB TEMP(C) 21.0
RELATIVE HUMIDITY = 48.80
HUMIDITY CORRECTION FACTOR = .91
GRAINS OF WATER/LB DRY AIR = 52.87

SPEED	POWER-(KW)		BMEP-(bar)		TORQUE-(NM)		FUEL-CONSUMPTION			BSFC	BOSCH	CELESCO	CORRECTED
REV/S	UN.CORR	CORR	UN.CORR	CORR	UN.CORR	CORR	G/HR	MM3/INJ	MG/LITRE	G/KW.H	SMOKE	SMOKE	AIR FLOW(SFAI)
20.00	12.58	12.48	8.63	8.57	100.10	99.35	7748.	67.62	147.66	616.0	.0	.0	.0000
30.00	20.89	20.73	9.55	9.48	110.80	109.97	11929.	69.40	151.55	571.1	.0	.0	.0000
40.00	29.63	29.41	10.16	10.09	117.90	117.02	16731.	73.01	159.42	564.6	.0	.0	.0000
50.00	40.93	40.70	11.23	11.17	130.30	129.55	22968.	80.11	175.08	561.1	.0	.0	.0000
60.00	47.65	47.54	10.90	10.87	126.40	126.11	25959.	75.45	164.90	544.8	.0	.0	.0000
70.00	45.74	45.71	8.97	8.96	104.00	103.94	26005.	64.78	141.60	568.5	.0	.0	.0000
80.00	41.67	41.64	7.15	7.14	82.90	82.85	25982.	56.64	123.79	623.5	.0	.0	.0000

MAN.PRES	MAN.TEMP	INTAKE-AIR-(M3/S)		AIR-MASS	FREE-AIR-VOL.EFF.		VOL.EFF.	MANIFOLD-VOL.EFF.		AIR/FUEL-RATIO		EQUIVALENCE-RATIO	
MM.HG	C	FREE	AFT.MET	KG/S	AIR-MET.	SPINDT	AFT.MET	AIR-MET.	SPINDT	AIR-MET.	SPINDT	AIR-MET.	EMISSIONS
-1.50	.0	.0000	.0000	.0000	.00	70.19	.00	.00	66.90	.00	5.83	.000	1.105
-2.26	.0	.0000	.0000	.0000	.00	72.24	.00	.00	68.85	.00	5.85	.000	1.101
-3.01	.0	.0000	.0000	.0000	.00	75.49	.00	.00	71.95	.00	5.81	.000	1.109
-3.76	.0	.0000	.0000	.0000	.00	83.28	.00	.00	79.10	.00	5.81	.000	1.108
-4.51	.0	.0000	.0000	.0000	.00	81.49	.00	.00	76.86	.00	6.00	.000	1.074
-103.02	.0	.0000	.0000	.0000	.00	69.33	.00	.00	65.18	.00	5.92	.000	1.087
-193.26	.0	.0000	.0000	.0000	.00	60.10	.00	.00	56.50	.00	5.87	.000	1.096

HC-PPM	HC-PPM	H C	NOX-PPM	NOX-PPM	NOX-PPM	NOX	CO-PPM	CO-PPM	C O	CO2-(%)	CO2-(%)	CO2	O 2
WET	DRY	G/H	WET	DRY	DRY.COR.	G/H	WET	DRY	G/H	WET	DRY	G/H	%
3919.5	5100.0	121.14	999.1	1300.0	1183.7	80.78	16907.6	22000.0	914.02	10.45	13.60	8877.9	.25
2768.2	3600.0	132.86	845.8	1100.0	1001.6	106.21	17685.9	23000.0	1484.75	10.38	13.50	13692.9	.20
2762.8	3600.0	184.07	844.2	1100.0	1001.6	147.15	19185.8	25000.0	2235.91	10.36	13.50	18970.6	.20
2231.0	2910.0	203.88	881.7	1150.0	1047.1	210.79	19933.7	26000.0	3186.18	10.35	13.50	25993.7	.20
1330.4	1740.0	138.77	1032.2	1350.0	1229.3	281.67	16056.2	21000.0	2929.44	10.70	14.00	30685.4	.20
873.0	1140.0	91.42	842.4	1100.0	1001.6	230.77	18379.9	24000.0	3366.33	10.49	13.70	30192.9	.30
596.5	780.0	61.87	764.8	1000.0	910.6	207.51	20648.4	27000.0	3745.85	10.40	13.60	29645.9	.20

PARTICULATES		H C	NOX	C O	CO2	START	END	START	IGNITION	EXHAUST	BRAKE	E.G.R.	BOOST PRESS.
G/H	G/KW.H	G/KW.H	G/KW.H	G/KW.H	G/KW.H	INJ.	INJ.	COMB.	TIMING	TEMP.C	THERM.EFF	(%)	RATIO
.00	.000	9.630	6.422	72.663	705.78	.0	.0	.0	10.0	389.0	29.31	.00	.998
.00	.000	6.362	5.085	71.091	655.63	.0	.0	.0	14.0	467.0	31.61	.00	.997
.00	.000	6.212	4.966	75.457	640.23	.0	.0	.0	16.0	540.0	31.98	.00	.996
.00	.000	4.981	5.149	77.835	635.00	.0	.0	.0	16.0	593.0	32.18	.00	.995
.00	.000	2.912	5.911	61.476	643.95	.0	.0	.0	17.0	626.0	33.14	.00	.994
.00	.000	1.999	5.045	73.595	660.08	.0	.0	.0	18.0	631.0	31.76	.00	.864
.00	.000	1.485	4.980	89.893	711.44	.0	.0	.0	18.0	636.0	28.96	.00	.745

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH DISTRIBUTOR IGNITION

MIXTURE LOOP AT 40 REV/SEC 5.5 BAR BMEP

REFER TO FIGURE NOS. 27-30

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
27	3	85	13.00	759.02	13.00	19.50	0	0.	4

1 ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00	40.00	40.00
28 IGNITION TIMING	14.00	16.50	18.50	20.00	22.00	36.00
4 FUEL VOLUME (CC)	102.50	102.50	102.50	102.50	102.50	102.50
2 BRAKE LOAD	63.80	63.80	63.80	63.80	63.80	63.80
5 FUEL TIME (SEC)	30.10	31.75	32.60	32.80	32.55	31.40
6 FUEL TEMPERATURE (C)	13.00	12.00	13.00	13.00	13.00	12.00
8 AIR METER TEMPERATURE (C)	18.00	18.00	19.00	19.00	19.00	17.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-255.68	-252.67	-215.82	-179.73	-129.34	-45.12
26 EXHAUST TEMP. (POST TURBO)	476.0	490.0	479.0	469.0	460.0	442.0
27 EXHAUST PRESSURE (POST TURBO)	19.6	20.3	22.6	26.3	30.8	41.4
13 CARBON MONOXIDE (%)	2.400	.600	.145	.145	.135	.218
15 CARBON DIOXIDE (%)	13.600	14.500	12.900	11.400	9.900	8.100
16 OXYGEN (%)	.200	.500	2.800	5.200	7.200	9.500
12 HYDROCARBONS (PPMC)	1950.0	1440.0	1380.0	1980.0	2730.0	3600.0
14 OXIDES OF NITROGEN (PPM)	790.0	1450.0	1500.0	740.0	200.0	42.0

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH DISTRIBUTOR IGNITION

REFER TO FIGURE NOS. 27-30

MIXTURE LOOP AT 40 REV/SEC 5.5 BAR BMEP

DATE 27/ 3/85 TEST NO. 13.0 BAROMETER 759.02 MM.HG WET BULB TEMP(C) 13.0
DRY BULB TEMP(C) 19.5

RELATIVE HUMIDITY = 46.74
HUMIDITY CORRECTION FACTOR = .88
GRAINS OF WATER/LB DRY AIR = 46.02

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	16.03	5.50	63.80	608.9	45.2(.0)	5.9(.0)	29.65	3.67	3.75	78.92	702.64	7.42
40.0	16.03	5.50	63.80	577.8	46.6(.0)	6.4(.0)	31.25	2.73	6.94	19.69	755.20	9.67
40.0	16.03	5.50	63.80	562.2	51.7(.0)	7.3(.0)	32.11	2.94	8.08	5.41	755.96	11.02
40.0	16.03	5.50	63.80	558.8	58.0(.0)	8.2(.0)	32.31	4.71	4.45	6.03	745.41	9.16
40.0	16.03	5.50	63.80	563.1	65.8(.0)	9.2(.0)	32.06	7.46	1.38	6.45	743.11	8.84
40.0	16.03	5.50	63.80	584.2	79.4(.0)	10.8(.0)	30.90	12.12	.36	12.84	749.33	12.48

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH DISTRIBUTOR IGNITION

REFER TO FIGURE NOS. 31-34

MIXTURE LOOP AT 60 REV/SEC 2.5 BAR BMEP

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
27	3	85	14.00	759.02	13.00	19.50	0	0.	4

1 ENGINE SPEED (REV/S)	60.00	60.00	60.00	60.00	60.00	60.00
28 IGNITION TIMING	16.00	18.50	20.50	23.00	28.50	42.00
4 FUEL VOLUME (CC)	203.00	203.00	203.00	203.00	203.00	203.00
2 BRAKE LOAD	29.00	29.00	29.00	29.00	29.00	29.00
5 FUEL TIME (SEC)	58.90	63.90	66.70	67.45	67.60	63.45
6 FUEL TEMPERATURE (C)	12.00	13.00	13.00	13.00	13.00	12.00
8 AIR METER TEMPERATURE (C)	18.00	19.00	20.00	19.00	19.00	17.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-436.16	-433.90	-412.85	-384.27	-347.42	-272.22
26 EXHAUST TEMP. (POST TURBO)	454.0	495.0	490.0	475.0	466.0	422.0
27 EXHAUST PRESSURE (POST TURBO)	16.5	18.8	21.1	24.1	28.6	42.9
13 CARBON MONOXIDE (%)	2.400	.550	.182	.124	.117	.227
15 CARBON DIOXIDE (%)	13.500	14.700	13.000	11.000	9.700	7.600
16 OXYGEN (%)	.200	.500	2.900	5.400	7.400	10.400
12 HYDROCARBONS (PPMC)	1680.0	1020.0	840.0	1350.0	1860.0	5400.0
14 OXIDES OF NITROGEN (PPM)	460.0	790.0	680.0	250.0	90.0	20.0

EPA/VW HRCC METHANOL (79.5mm x 73.4mm)

M.E.C./BOSCH DISTRIBUTOR IGNITION

REFER TO FIGURE NOS. 31-34

MIXTURE LOOP AT 60 REV/SEC 2.5 BAR BMEP

DATE 27/ 3/85 TEST NO. 14.0 BAROMETER 759.02 mm.HG WET BULB TEMP(C) 13.0
DRY BULB TEMP(C) 19.5

RELATIVE HUMIDITY = 46.74
HUMIDITY CORRECTION FACTOR = .88
GRAINS OF WATER/LB DRY AIR = 46.02

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
60.0	10.93	2.50	29.00	904.7	30.6(.0)	5.9(.0)	19.96	4.73	3.27	118.18	1044.47	8.00
60.0	10.93	2.50	29.00	833.2	30.8(.0)	6.4(.0)	21.67	2.77	5.42	26.10	1096.22	8.18
60.0	10.93	2.50	29.00	798.2	35.6(.0)	7.3(.0)	22.62	2.53	5.17	9.58	1074.79	7.70
60.0	10.93	2.50	29.00	789.3	38.1(.0)	8.4(.0)	22.87	4.73	2.21	7.60	1059.64	6.95
60.0	10.93	2.50	29.00	787.6	42.9(.0)	9.5(.0)	22.92	7.32	.90	8.06	1049.40	8.22
60.0	10.93	2.50	29.00	839.8	54.2(.0)	11.3(.0)	21.50	27.10	.25	19.93	1048.22	27.35

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH DISTRIBUTOR IGNITION

REFER TO FIGURE NOS. 23-26

MIXTURE LOOP AT 40 REV/SEC 2.5 BAR BMEP (REPEAT OF EPA.7)

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPFRATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
28	3	85	17.00	764.09	13.00	22.00	0	0.	4

1 ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00	40.00	40.00
28 IGNITION TIMING	14.00	17.00	20.00	21.00	28.00	38.00
4 FUEL VOLUME (CC)	102.50	102.50	102.50	102.50	102.50	102.50
2 BRAKE LOAD	29.00	29.00	29.00	29.00	29.00	29.00
5 FUEL TIME (SEC)	45.70	49.30	50.90	52.30	51.95	50.15
6 FUEL TEMPERATURE (C)	13.00	12.00	13.00	13.00	13.00	13.00
8 AIR METER TEMPERATURE (C)	23.00	20.00	21.00	20.00	20.00	20.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-430.90	-427.14	-411.34	-380.51	-348.93	-297.04
26 EXHAUST TEMP. (POST TURBO)	402.0	410.0	406.0	393.0	386.0	373.0
27 EXHAUST PRESSURE (POST TURBO)	6.8	7.5	7.5	9.8	11.3	16.5
13 CARBON MONOXIDE (%)	2.450	.550	.180	.138	.140	.205
15 CARBON DIOXIDE (%)	13.700	14.500	13.100	11.100	9.900	8.200
16 OXYGEN (%)	.200	.650	2.500	5.400	7.400	9.700
12 HYDROCARBONS (PPMC)	1875.0	1170.0	1230.0	2040.0	2670.0	4000.0
14 OXIDES OF NITROGEN (PPM)	420.0	820.0	840.0	280.0	130.0	48.0

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH DISTRIBUTOR IGNITION

REFER TO FIGURE NOS. 23-26

MIXTURE LOOP AT 40 REV/SEC 2.5 BAR BMEP (REPEAT OF EPA.7)

DATE 28/ 3/85 TEST NO. 17.0 BAROMETER 764.09 MM.HG WET BULB TEMP(C) 13.0
DRY BULB TEMP(C) 22.0

RELATIVE HUMIDITY = 33.54
HUMIDITY CORRECTION FACTOR = .84
GRAINS OF WATER/LB DRY AIR = 38.19

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: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
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RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	7.29	2.50	29.00	882.3	30.1(.0)	5.9(.0)	20.46	5.06	2.74	115.72	1016.68	7.81
40.0	7.29	2.50	29.00	818.6	30.3(.0)	6.5(.0)	22.05	3.16	5.35	25.96	1075.43	8.51
40.0	7.29	2.50	29.00	792.2	32.6(.0)	7.1(.0)	22.79	3.63	6.00	9.30	1063.94	9.64
40.0	7.29	2.50	29.00	771.0	36.8(.0)	8.3(.0)	23.42	6.87	2.28	8.13	1027.74	9.15
40.0	7.29	2.50	29.00	776.2	41.5(.0)	9.3(.0)	23.26	10.05	1.18	9.22	1024.43	11.24
40.0	7.29	2.50	29.00	804.0	49.4(.0)	10.7(.0)	22.45	21.72	.53	16.22	1019.65	22.24

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

REFER TO FIGURE NOS. 51-54

M.E.C./BOSCH DISTRIBUTOR IGNITION

IGNITION SWING AT 40 REV/SEC 2.5 BAR 0.8 EQUIV. RATIO

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
30	3	85	18.00	753.60	13.50	19.00	0	0.	4

1 ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00	40.00	40.00
28 IGNITION TIMING	30.00	25.00	20.00	15.00	10.00	5.00
4 FUEL VOLUME (CC)	102.50	102.50	102.50	102.50	102.50	102.50
2 BRAKE LOAD	29.00	29.00	29.00	29.00	29.00	29.00
5 FUEL TIME (SEC)	52.00	52.15	52.20	52.00	50.45	47.55
6 FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00	12.00	12.00
8 AIR METER TEMPERATURE (C)	19.00	21.00	20.00	19.00	19.00	21.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-374.50	-375.25	-375.25	-373.74	-363.97	-342.91
26 EXHAUST TEMP. (POST TURBO)	391.0	394.0	394.0	400.0	416.0	443.0
27 EXHAUST PRESSURE (POST TURBO)	9.8	9.8	9.8	9.8	9.8	9.8
13 CARBON MONOXIDE (%)	.158	.145	.145	.140	.130	.113
15 CARBON DIOXIDE (%)	11.400	11.400	11.500	11.500	11.500	11.500
16 OXYGEN (%)	4.900	4.900	4.900	4.900	4.900	4.900
12 HYDROCARBONS (PPMC)	2040.0	2040.0	2040.0	2040.0	2040.0	2040.0
14 OXIDES OF NITROGEN (PPM)	480.0	380.0	290.0	205.0	130.0	80.0

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

N.E.C./BOSCH DISTRIBUTOR IGNITION

REFER TO FIGURE NOS. 51-54

IGNITION SWING AT 40 REV/SEC 2.5 BAR 0.8 EQUIV. RATIO

DATE 30/ 3/85 TEST NO. 18.0 BAROMETER 753.60 MM.HG WET BULB TEMP(C) 13.5
DRY BULB TEMP(C) 19.0

RELATIVE HUMIDITY = 53.67
HUMIDITY CORRECTION FACTOR = .91
GRAINS OF WATER/LB DRY AIR = 51.65

: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :

RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	7.29	2.50	29.00	776.1	36.3(.0)	8.1(.0)	23.26	6.73	4.12	9.12	1033.67	10.85
40.0	7.29	2.50	29.00	773.9	36.5(.0)	8.1(.0)	23.33	6.72	3.25	8.35	1031.83	9.97
40.0	7.29	2.50	29.00	773.2	36.3(.0)	8.1(.0)	23.35	6.66	2.46	8.27	1031.11	9.12
40.0	7.29	2.50	29.00	776.1	36.3(.0)	8.1(.0)	23.26	6.68	1.75	8.02	1035.51	8.43
40.0	7.29	2.50	29.00	800.0	37.4(.0)	8.1(.0)	22.57	6.90	1.14	7.69	1068.23	8.04
40.0	7.29	2.50	29.00	848.8	40.0(.0)	8.1(.0)	21.27	7.33	.75	7.10	1135.01	8.07

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH DISTRIBUTOR IGNITION

REFER TO FIGURE NOS. 55-58

IGNITION SWING AT 40 REV/SEC 5.5 BAR 0.8 EQUIV. RATIO

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
31	3	85	21.00	758.20	15.50	23.00	0	0.	4

1 ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00	40.00	40.00
28 IGNITION TIMING	30.00	25.00	20.00	15.00	10.00	5.00
4 FUEL VOLUME (CC)	203.00	203.00	203.00	203.00	203.00	203.00
2 BRAKE LOAD	63.80	63.80	63.80	63.80	63.80	63.80
5 FUEL TIME (SEC)	63.20	63.95	64.15	63.05	61.25	58.45
6 FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00	12.00	12.00
8 AIR METER TEMPERATURE (C)	21.00	21.00	21.00	21.00	22.00	22.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-169.95	-172.21	-173.71	-169.20	-157.92	-138.37
26 EXHAUST TEMP. (POST TURBO)	469.0	465.0	466.0	474.0	492.0	516.0
27 EXHAUST PRESSURE (POST TURBO)	27.1	27.1	27.1	27.1	27.1	27.1
13 CARBON MONOXIDE (%)	.148	.150	.155	.148	.136	.128
15 CARBON DIOXIDE (%)	11.500	11.500	11.400	11.500	11.500	11.500
16 OXYGEN (%)	4.900	4.900	4.900	4.900	4.900	4.900
12 HYDROCARBONS (PPMC)	2040.0	1950.0	1950.0	1950.0	1950.0	1950.0
14 OXIDES OF NITROGEN (PPM)	1200.0	950.0	750.0	520.0	320.0	180.0

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

REFER TO FIGURE NOS. 55-58

M.E.C./BOSCH DISTRIBUTOR IGNITION

IGNITION SWING AT 40 REV/SEC 5.5 BAR 0.8 EQUIV. RATIO

DATE 31/ 3/85   TEST NO. 21.0   BAROMETER 758.20 MM.HG   WET BULB TEMP(C) 15.5
DRY BULB TEMP(C) 23.0

RELATIVE HUMIDITY = 44.70
HUMIDITY CORRECTION FACTOR = .92
GRAINS OF WATER/LB DRY AIR = 54.71

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: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	16.03	5.50	63.80	574.9	59.2(.0)	8.1(.0)	31.41	4.95	7.68	6.28	766.48	12.63
40.0	16.03	5.50	63.80	568.1	58.6(.0)	8.1(.0)	31.78	4.68	6.01	6.29	757.93	10.69
40.0	16.03	5.50	63.80	566.4	58.5(.0)	8.1(.0)	31.88	4.70	4.77	6.53	755.06	9.47
40.0	16.03	5.50	63.80	576.2	59.4(.0)	8.1(.0)	31.33	4.74	3.34	6.30	768.88	8.08
40.0	16.03	5.50	63.80	593.2	61.4(.0)	8.1(.0)	30.44	4.89	2.12	5.96	792.28	7.01
40.0	16.03	5.50	63.80	621.6	64.3(.0)	8.1(.0)	29.04	5.13	1.25	5.69	830.80	6.37

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH DISTRIBUTOR IGNITION

MIXTURE LOOP AT 40 REV/SEC 1.5 BAR BMEP

REFER TO FIGURE NOS. 19-22

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
1	4	85	25.00	754.65	14.50	21.00	0	0.	4

1 ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00	40.00	40.00
28 IGNITION TIMING	16.00	18.50	20.00	21.50	27.00	37.00
4 FUEL VOLUME (CC)	102.50	102.50	102.50	102.50	102.50	102.50
2 BRAKE LOAD	17.40	17.40	17.40	17.40	17.40	17.40
5 FUEL TIME (SEC)	58.00	61.85	64.20	66.00	66.05	63.40
6 FUEL TEMPERATURE (C)	13.00	13.00	13.00	13.00	13.00	13.00
8 AIR METER TEMPERATURE (C)	22.00	22.00	22.00	22.00	22.00	21.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-479.02	-473.01	-460.98	-436.42	-409.09	-369.23
26 EXHAUST TEMP. (POST TURBO)	363.0	372.0	371.0	366.0	360.0	348.0
27 EXHAUST PRESSURE (POST TURBO)	5.3	5.3	6.0	6.8	8.3	12.0
13 CARBON MONOXIDE (%)	2.400	.600	.192	.143	.165	.214
15 CARBON DIOXIDE (%)	13.500	14.300	13.000	11.200	9.500	7.900
16 OXYGEN (%)	.200	.650	2.500	5.300	7.100	9.600
12 HYDROCARBONS (PPMC)	2130.0	1320.0	1350.0	1920.0	2820.0	4800.0
14 OXIDES OF NITROGEN (PPM)	260.0	500.0	400.0	175.0	80.0	34.0

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH DISTRIBUTOR IGNITION

MIXTURE LOOP AT 40 REV/SEC 1.5 BAR BMEP

REFER TO FIGURE NOS. 19-22

DATE 1/ 4/85 TEST NO. 25.0 BAROMETER 754.65 MM.HG WET BULB TEMP(C) 14.5
DRY BULB TEMP(C) 21.0

RELATIVE HUMIDITY = 48.87
HUMIDITY CORRECTION FACTOR = .91
GRAINS OF WATER/LB DRY AIR = 53.18

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)		AIR FUEL RATIO		B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	4.37	1.50	17.40	1158.7	23.9(	.0)	5.9(	.0)	15.58	7.66	2.45	150.93	1333.96	10.11
40.0	4.37	1.50	17.40	1086.6	24.5(	.0)	6.4(	.0)	16.62	4.77	4.73	37.93	1420.34	9.51
40.0	4.37	1.50	17.40	1046.8	26.2(	.0)	7.1(	.0)	17.25	5.30	4.12	13.19	1403.10	9.42
40.0	4.37	1.50	17.40	1018.2	29.5(	.0)	8.3(	.0)	17.73	8.47	2.02	11.04	1358.53	10.50
40.0	4.37	1.50	17.40	1017.5	33.6(	.0)	9.4(	.0)	17.74	14.42	1.07	14.76	1335.28	15.49
40.0	4.37	1.50	17.40	1060.0	40.1(	.0)	10.8(	.0)	17.03	29.60	.55	23.08	1338.93	30.15

EPA/VW BRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH DISTRIBUTOR IGNITION

REFER TO FIGURE NOS. 35-38

MIXTURE LOOP AT 60 REV/SEC 5.5 BAR BMEP

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
1	4	85	26.00	754.65	14.50	21.00	0	0.	4

1 ENGINE SPEED (REV/S)	60.00	60.00	60.00	60.00	60.00	60.00
28 IGNITION TIMING	16.50	18.00	20.00	22.00	25.50	35.00
4 FUEL VOLUME (CC)	203.00	203.00	203.00	203.00	203.00	203.00
2 BRAKE LOAD	63.80	63.80	63.80	63.80	63.80	63.80
5 FUEL TIME (SEC)	37.05	39.80	41.30	42.15	42.20	40.65
6 FUEL TEMPERATURE (C)	14.00	13.00	14.00	14.00	14.00	13.00
8 AIR METER TEMPERATURE (C)	24.00	23.00	24.00	23.00	23.00	22.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-268.46	-261.70	-233.12	-183.49	-118.82	-39.86
26 EXHAUST TEMP. (POST TURBO)	554.0	577.0	568.0	540.0	515.0	490.0
27 EXHAUST PRESSURE (POST TURBO)	42.9	46.6	48.9	55.6	66.9	85.0
13 CARBON MONOXIDE (%)	2.500	.600	.170	.138	.112	.180
15 CARBON DIOXIDE (%)	13.500	14.400	13.000	11.100	9.700	8.300
16 OXYGEN (%)	.200	.550	2.400	5.050	7.300	9.300
12 HYDROCARBONS (PPMC)	1680.0	1050.0	720.0	960.0	1440.0	2880.0
14 OXIDES OF NITROGEN (PPM)	840.0	1550.0	1600.0	680.0	175.0	55.0

EPA/VW HPCC METHANOL (79.5mm X 73.4mm)

B.E.C./BOSCH DISTRIBUTOR IGNITION

REFER TO FIGURE NOS. 35-38

MIXTURE LOOP AT 60 REV/SEC 5.5 BAR BMEP

DATE 1/ 4/85 TEST NO. 26.0 BAROMETER 754.65 MM.HG WET BULB TEMP(C) 14.5
DRY BULB TEMP(C) 21.0

RELATIVE HUMIDITY = 48.87
HUMIDITY CORRECTION FACTOR = .91
GRAINS OF WATER/LB DRY AIR = 53.18

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)		AIR FUEL RATIO		B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
60.0	24.05	5.50	63.80	652.6	49.6(	.0)	5.9(	.0)	27.67	3.39	4.44	88.24	745.71	7.83
60.0	24.05	5.50	63.80	608.0	50.4(	.0)	6.4(	.0)	29.69	2.11	8.17	21.12	796.49	10.29
60.0	24.05	5.50	63.80	585.4	54.2(	.0)	7.2(	.0)	30.84	1.59	9.27	6.57	769.71	10.86
60.0	24.05	5.50	63.80	573.6	61.2(	.0)	8.3(	.0)	31.47	2.43	4.51	6.11	771.92	6.94
60.0	24.05	5.50	63.80	572.9	70.0(	.0)	9.5(	.0)	31.51	4.14	1.32	5.64	767.01	5.46
60.0	24.05	5.50	63.80	595.3	82.2(	.0)	10.7(	.0)	30.33	9.78	.49	10.69	774.35	10.27

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH DISTRIBUTOR IGNITION

REFER TO FIGURE NOS. 39-42

MIXTURE LOOP AT 60 REV/SEC 7.0 BAR BMEP

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
1	4	85	27.00	754.65	14.50	21.00	0	0.	4

1 ENGINE SPEED (REV/S)	60.00	60.00	60.00	60.00	60.00	60.00
28 IGNITION TIMING	16.00	18.00	19.50	21.00	26.00	32.00
4 FUEL VOLUME (CC)	304.00	304.00	304.00	304.00	304.00	304.00
2 BRAKE LOAD	81.20	81.20	81.20	81.20	81.20	81.20
5 FUEL TIME (SEC)	46.70	49.85	51.80	53.25	53.25	52.55
6 FUEL TEMPERATURE (C)	14.00	13.00	13.00	13.00	13.00	13.00
8 AIR METER TEMPERATURE (C)	22.00	23.00	24.00	23.00	24.00	22.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-191.76	-181.98	-145.14	-84.22	-38.35	-6.02
26 EXHAUST TEMP. (POST TURBO)	576.0	603.0	591.0	564.0	537.0	525.0
27 EXHAUST PRESSURE (POST TURBO)	57.9	62.4	66.9	77.5	85.7	95.5
13 CARBON MONOXIDE (%)	2.300	.600	.158	.135	.118	.129
15 CARBON DIOXIDE (%)	13.800	14.300	13.300	11.500	10.200	9.500
16 OXYGEN (%)	.200	.550	2.400	4.900	6.750	7.800
12 HYDROCARBONS (PPMC)	1740.0	1020.0	570.0	640.0	1290.0	1740.0
14 OXIDES OF NITROGEN (PPM)	950.0	1900.0	1800.0	780.0	320.0	190.0

EPA/VW HRCC METHANOL (79.5mm x 73.4mm)

M.E.C./BOSCH DISTRIBUTOR IGNITION

MIXTURE LOOP AT 60 REV/SEC 7.0 BAR BMEP

REFER TO FIGURE NOS. 39-42

DATE 1/ 4/85   TEST NO. 27.0   BAROMETER 754.65 MM.HG   WET BULB TEMP(C) 14.5
DRY BULB TEMP(C) 21.0

RELATIVE HUMIDITY = 48.87
HUMIDITY CORRECTION FACTOR = .91
GRAINS OF WATER/LB DRY AIR = 53.18

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
60.0	30.61	7.00	81.20	609.2	59.1(.0)	5.9(.0)	29.64	3.26	4.66	75.29	709.80	7.91
60.0	30.61	7.00	81.20	571.2	60.3(.0)	6.4(.0)	31.61	1.94	9.48	19.98	748.15	11.42
60.0	30.61	7.00	81.20	549.7	64.8(.0)	7.2(.0)	32.84	1.16	9.59	5.62	743.31	10.75
60.0	30.61	7.00	81.20	534.7	71.7(.0)	8.2(.0)	33.76	1.92	4.66	5.39	721.03	6.58
60.0	30.61	7.00	81.20	534.7	80.3(.0)	9.1(.0)	33.76	3.30	2.15	5.28	717.39	5.45
60.0	30.61	7.00	81.20	541.8	86.1(.0)	9.7(.0)	33.32	4.81	1.38	6.24	721.53	6.18

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH DISTRIBUTOR IGNITION

REFER TO FIGURE NOS. 43-46

MIXTURE LOOP AT 15 REV/SEC IDLE

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
2	4	85	28.00	766.50	15.50	23.50	0	0.	4

1	ENGINE SPEED (REV/S)	15.00	15.00	15.00	15.00	15.00	15.00
28	IGNITION TIMING	20.00	20.00	20.00	20.00	20.00	20.00
4	FUEL VOLUME (CC)	52.00	52.00	52.00	52.00	52.00	52.00
2	BRAKE LOAD	.00	.00	.00	.00	.00	.00
5	FUEL TIME (SEC)	140.95	147.20	152.10	156.90	159.40	156.15
6	FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00	12.00	12.00
8	AIR METER TEMPERATURE (C)	29.00	36.00	32.00	34.00	35.00	36.00
11	INTAKE MANIFOLD PRESS.(mm.Hg)	-562.50	-563.25	-557.23	-550.46	-545.95	-530.91
26	EXHAUST TEMP. (POST TURBO)	105.0	109.0	109.0	111.0	116.0	121.0
27	EXHAUST PRESSURE (POST TURBO)	.0	.0	.0	.0	.0	.0
13	CARBON MONOXIDE (%)	2.600	1.600	.800	.250	.220	.240
15	CARBON DIOXIDE (%)	12.900	13.200	12.900	12.200	11.100	10.000
16	OXYGEN (%)	1.100	1.600	2.300	3.900	5.400	7.000
12	HYDROCARBONS (PPMC)	3600.0	3600.0	3600.0	4650.0	5400.0	6600.0
14	OXIDES OF NITROGEN (PPM)	12.0	14.0	14.0	13.0	12.0	10.0

EPA/VW HPLC METHANOL (79.5mm X 73.4mm)

M.F.C./BOSCH DISTRIBUTOR IGNITION

MIXTURE LOOP AT 15 REV/SEC IDLE

REFER TO FIGURE NOS. 43-46

DATE 27 4/85 TEST NO. 28.0 BAROMETER 766.50 MM.HG WET BULB TEMP(C) 15.5
DRY BULB TEMP(C) 23.5

RELATIVE HUMIDITY = 42.01
HUMIDITY CORRECTION FACTOR = .91
GRAINS OF WATER/LB DRY AIR = 52.38

: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :

RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
15.0	.00	.00	.00	1058.8	13.7(.0)	6.0(.0)	.00	12.02	.10	151.79	1183.31	12.12
15.0	.00	.00	.00	1013.8	14.2(.0)	6.4(.0)	.00	12.04	.12	93.57	1212.95	12.16
15.0	.00	.00	.00	981.1	14.5(.0)	6.8(.0)	.00	12.56	.13	48.62	1236.95	12.69
15.0	.00	.00	.00	951.1	15.5(.0)	7.4(.0)	.00	17.12	.12	16.10	1234.58	17.25
15.0	.00	.00	.00	936.2	16.6(.0)	8.0(.0)	.00	21.31	.12	15.19	1204.00	21.44
15.0	.00	.00	.00	955.7	18.4(.0)	8.7(.0)	.00	28.93	.11	18.40	1204.78	29.05

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH DISTRIBUTOR IGNITION

REFER TO FIGURE NOS. 47-50

IGNITION SWING AT 15 REV/SEC IDLE STOICH. AFR

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
2	4	85	29.00	766.50	15.50	23.50	0	0.	4

1 ENGINE SPEED (REV/S)	15.00	15.00	15.00	15.00	15.00	15.00
28 IGNITION TIMING	30.00	25.00	20.00	15.00	10.00	5.00
4 FUEL VOLUME (CC)	52.00	52.00	52.00	52.00	52.00	52.00
2 BRAKE LOAD	.00	.00	.00	.00	.00	.00
5 FUEL TIME (SEC)	145.45	146.00	146.40	145.40	142.00	137.70
6 FUEL TEMPERATURE (C)	13.00	12.00	12.00	12.00	12.00	12.00
8 AIR METER TEMPERATURE (C)	37.00	35.00	36.00	36.00	37.00	37.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-564.00	-565.50	-565.50	-564.00	-561.74	-556.48
26 EXHAUST TEMP. (POST TURBO)	112.0	109.0	108.0	110.0	114.0	120.0
27 EXHAUST PRESSURE (POST TURBO)	.0	.0	.0	.0	.0	.0
13 CARBON MONOXIDE (%)	1.600	1.650	1.500	1.500	1.400	1.400
15 CARBON DIOXIDE (%)	13.200	13.200	13.200	13.300	13.400	13.500
16 OXYGEN (%)	1.600	1.500	1.400	1.350	1.400	1.300
12 HYDROCARBONS (PPMC)	3900.0	3600.0	3450.0	3150.0	2640.0	2220.0
14 OXIDES OF NITROGEN (PPM)	16.0	13.0	13.0	12.0	11.0	10.0

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH DISTRIBUTOR IGNITION

REFER TO FIGURE NOS. 47-50

IGNITION SWING AT 15 REV/SEC IDLE STOICH. AFR

DATE 27/ 4/85 TEST NO. 29.0 BAROMETER 766.50 MM.HG WET BULB TEMP(C) 15.5
DRY BULB TEMP(C) 23.5

RELATIVE HUMIDITY = 42.01
HUMIDITY CORRECTION FACTOR = .91
GRAINS OF WATER/LB DRY AIR = 52.38

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)		AIR FUEL RATIO		B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
15.0	.00	.00	.00	1025.1	14.4(	.0)	6.4(	.0)	.00	13.16	.14	94.45	1224.01	13.30
15.0	.00	.00	.00	1022.1	14.2(	.0)	6.3(	.0)	.00	12.10	.11	96.97	1218.90	12.21
15.0	.00	.00	.00	1019.3	14.3(	.0)	6.3(	.0)	.00	11.69	.11	88.68	1228.90	11.80
15.0	.00	.00	.00	1026.4	14.3(	.0)	6.3(	.0)	.00	10.69	.11	89.08	1240.96	10.80
15.0	.00	.00	.00	1050.9	14.9(	.0)	6.4(	.0)	.00	9.21	.10	85.42	1264.56	9.31
15.0	.00	.00	.00	1083.7	15.3(	.0)	6.4(	.0)	.00	7.95	.09	87.75	1329.44	8.05

EPA/VW HRCC METHANOL (79.5mm x 73.4mm)

BOSCH/M.E.C. IGNITION - CORRECT FUEL INJECTORS

REFER TO FIGURE NOS. 14-17 and 59-62

FULL LOAD POWER CURVE-LBT FUELLING,MBT IGN TIMING

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
25	11	85	36.00	765.21	13.00	22.00	1	0.	1

1 ENGINE SPEED (REV/S)	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00
28 IGNITION TIMING	7.00	11.00	14.00	16.00	16.00	17.00	18.00	20.00
4 FUEL VOLUME (CC)	203.00	203.00	304.00	304.00	507.00	507.00	507.00	507.00
2 BRAKE LOAD	98.00	107.50	113.40	125.70	122.90	118.80	117.20	113.60
5 FUEL TIME (SEC)	79.00	49.80	54.30	39.10	55.50	47.50	40.30	36.20
6 FUEL TEMPERATURE (C)	14.00	14.00	13.00	13.00	13.00	13.00	12.00	12.00
8 AIR METER TEMPERATURE (C)	17.00	16.00	19.00	18.00	18.00	19.00	20.00	22.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-.75	-1.50	-1.50	-2.26	-3.01	-4.51	-6.02	-7.52
26 EXHAUST TEMP. (POST TURBO)	378.0	456.0	519.0	577.0	611.0	633.0	655.0	691.0
27 EXHAUST PRESSURE (POST TURBO)	16.5	24.1	44.4	78.2	107.5	144.4	197.0	243.6
13 CARBON MONOXIDE (%)	2.100	2.500	2.300	2.600	2.300	3.000	2.900	2.800
15 CARBON DIOXIDE (%)	13.700	13.500	13.500	13.300	13.500	13.000	13.300	13.500
16 OXYGEN (%)	.250	.200	.200	.200	.250	.200	.200	.200
12 HYDROCARBONS (PPMC)	1470.0	1860.0	1920.0	2520.0	1500.0	1260.0	2190.0	2100.0
14 OXIDES OF NITROGEN (PPM)	1050.0	950.0	1100.0	1200.0	1350.0	950.0	1100.0	1350.0

EPA/VW DRCC METHANOL (79.5mm x 73.4mm)
BOSCH/M.E.C. IGNITION - CORRECT FUEL INJECTORS
FULL LOAD POWER CURVE-LBT FUELLING,MBT IGN TIMING

REFER TO FIGURE NOS. 14-17 and 59-62

DATE 25/11/85 TEST NO. 36.0 BAROMETER 765.21 MM.HG WET BULB TEMP(C) 13.0 DRY BULB TEMP(C) 22.0
RELATIVE HUMIDITY = 33.51
HUMIDITY CORRECTION FACTOR = .84 GRAINS OF WATER/LB DRY AIR = 38.10

SPEED	POWER-(KW)		BMEP-(bar)		TORQUE-(NM)		FUEL-CONSUMPTION			BSFC	BOSCH	CELESCO	CORRECTED
REV/S	UN.CORR	CORR	UN.CORR	CORR	UN.CORR	CORR	G/HR	MM3/INJ	MG/LITRE	G/KW.H	SMOKE	SMOKE	AIR FLOW(SLAI)
20.00	12.32	12.17	8.45	8.35	98.00	96.84	7361.	64.24	140.28	597.7	.0	.0	.0000
30.00	20.26	19.99	9.27	9.14	107.50	106.04	11677.	67.94	148.35	576.3	.0	.0	.0000
40.00	28.50	28.26	9.78	9.69	113.40	112.44	16052.	69.98	152.96	563.2	.0	.0	.0000
50.00	39.49	39.09	10.84	10.73	125.70	124.42	22292.	77.75	169.93	564.5	.0	.0	.0000
60.00	46.33	45.86	10.60	10.49	122.90	121.65	26192.	76.13	166.39	565.3	.0	.0	.0000
70.00	52.25	51.81	10.24	10.16	118.80	117.79	30604.	76.24	166.64	585.7	.0	.0	.0000
80.00	58.91	58.51	10.10	10.04	117.20	116.41	36104.	78.63	172.01	612.9	.0	.0	.0000
90.00	64.24	64.02	9.79	9.76	113.60	113.21	40194.	77.81	170.22	625.7	.0	.0	.0000

MAN.PRES	MAN.TEMP	INTAKE-AIR-(M3/S)		AIR-MASS	FREE-AIR-VOL.EFF.		VOL.EFF.	MANIFOLD-VOL.EFF.		AIR/FUEL-RATIO		EQUIVALENCE-RATIO	
MM.HG	C	FREE	AFT.MET	KG/S	AIR-MET.	SPINDT	AFT.MET	AIR-MET.	SPINDT	AIR-MET.	SPINDT	AIR-MET.	EMISSIONS
-.75	.0	.0000	.0000	.0000	.00	68.52	.00	.00	64.57	.00	5.99	.000	1.076
-1.50	.0	.0000	.0000	.0000	.00	70.83	.00	.00	66.98	.00	5.87	.000	1.097
-1.50	.0	.0000	.0000	.0000	.00	74.26	.00	.00	69.50	.00	5.91	.000	1.090
-2.26	.0	.0000	.0000	.0000	.00	81.01	.00	.00	76.07	.00	5.82	.000	1.106
-3.01	.0	.0000	.0000	.0000	.00	80.93	.00	.00	76.00	.00	5.94	.000	1.084
-4.51	.0	.0000	.0000	.0000	.00	79.07	.00	.00	74.00	.00	5.78	.000	1.115
-6.02	.0	.0000	.0000	.0000	.00	81.90	.00	.00	76.39	.00	5.78	.000	1.115
-7.52	.0	.0000	.0000	.0000	.00	82.05	.00	.00	76.01	.00	5.81	.000	1.109

HC-PPM	HC-PPM	H C	NOX-PPM	NOX-PPM	NOX-PPM	NOX	CO-PPM	CO-PPM	C O	CO2-(%)	CO2-(%)	CO2	O 2
WET	DRY	G/H	WET	DRY	DRY.COR.	G/H	WET	DRY	G/H	WET	DRY	G/H	%
1129.4	1470.0	33.93	806.7	1050.0	883.3	58.57	16134.8	21000.0	847.72	10.53	13.70	8689.5	.25
1427.8	1860.0	67.09	729.3	950.0	799.2	82.83	19191.0	25000.0	1577.29	10.36	13.50	13382.7	.20
1476.8	1920.0	96.36	846.1	1100.0	925.4	133.44	17690.6	23000.0	2019.01	10.38	13.50	18620.1	.20
1938.5	2520.0	173.90	923.1	1200.0	1009.5	200.16	20000.6	26000.0	3138.22	10.23	13.30	25223.2	.20
1153.7	1500.0	123.16	1038.4	1350.0	1135.7	267.92	17690.6	23000.0	3303.10	10.38	13.50	30462.5	.25
970.0	1260.0	119.56	731.3	950.0	799.2	217.89	23095.1	30000.0	4979.08	10.01	13.00	33900.7	.20
1679.8	2190.0	240.78	843.7	1100.0	925.4	292.32	22243.4	29000.0	5576.86	10.20	13.30	40186.6	.20
1607.3	2100.0	255.61	1033.3	1350.0	1135.7	397.19	21431.1	28000.0	5961.36	10.33	13.50	45160.6	.20

PARTICULATES		H C	NOX	C O	CO2	START	END	START	IGNITION	EXHAUST	BRAKE	E.G.R.	BOOST PRESS.
G/H	G/KW.H	G/KW.H	G/KW.H	G/KW.H	G/KW.H	INJ.	INJ.	COMB.	TIMING	TEMP.C	THERM.EFF	(%)	RATIO
.00	.000	2.755	4.756	68.836	705.60	.0	.0	.0	7.0	378.0	30.20	.00	.999
.00	.000	3.311	4.088	77.840	660.44	.0	.0	.0	11.0	456.0	31.33	.00	.998
.00	.000	3.381	4.682	70.841	653.33	.0	.0	.0	14.0	519.0	32.05	.00	.998
.00	.000	4.404	5.069	79.469	638.73	.0	.0	.0	16.0	577.0	31.98	.00	.997
.00	.000	2.658	5.783	71.292	657.48	.0	.0	.0	16.0	611.0	31.94	.00	.996
.00	.000	2.288	4.170	95.292	648.81	.0	.0	.0	17.0	633.0	30.82	.00	.994
.00	.000	4.087	4.962	94.666	682.16	.0	.0	.0	18.0	655.0	29.46	.00	.992
.00	.000	3.979	6.183	92.799	703.01	.0	.0	.0	20.0	691.0	28.86	.00	.990

EPA/VW HRCC METHANOL (79.5mm x 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

MIXTURE LOOP AT 40 REV/SEC 2.5 BAR BMEP

REFER TO FIGURE NOS. 23-26 and 63-66

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
25	1	86	40.00	772.20	9.50	17.00	0	0.	4

1	ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00	40.00	40.00
28	IGNITION TIMING	11.00	12.00	13.00	16.00	24.00	33.00
4	FUEL VOLUME (CC)	102.50	102.50	102.50	102.50	102.50	102.50
2	BRAKE LOAD	29.00	29.00	29.00	29.00	29.00	29.00
5	FUEL TIME (SEC)	46.15	49.80	51.10	53.10	53.65	51.70
6	FUEL TEMPERATURE (C)	11.00	11.00	11.00	11.00	11.00	11.00
8	AIR METER TEMPERATURE (C)	12.00	12.00	12.00	11.00	11.00	12.00
11	INTAKE MANIFOLD PRESS.(mm.Hg)	-414.35	-411.34	-395.55	-366.22	-333.89	-275.98
26	EXHAUST TEMP. (POST TURBO)	388.0	406.0	399.0	389.0	379.0	364.0
27	EXHAUST PRESSURE (POST TURBO)	9.0	9.0	10.5	12.0	12.8	16.5
13	CARBON MONOXIDE (%)	2.600	.500	.130	.115	.115	.193
15	CARBON DIOXIDE (%)	13.700	14.800	13.200	11.300	9.700	7.800
16	OXYGEN (%)	.200	.500	2.500	5.200	7.500	10.000
12	HYDROCARBONS (PPMC)	1030.0	750.0	840.0	1320.0	2010.0	3900.0
14	OXIDES OF NITROGEN (PPM)	-420.0	-760.0	-880.0	-330.0	-110.0	-34.0

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS **REFER TO FIGURE NOS. 23-26 and 66-66**

MIXTURE LOOP AT 40 REV/SEC 2.5 BAR BMEP

DATE 25/ 1/86 TEST NO. 40.0 BAROMETER 772.20 MM.HG WET BULB TEMP(C) 9.5
DRY BULB TEMP(C) 17.0

RELATIVE HUMIDITY = 34.73
HUMIDITY CORRECTION FACTOR = .79
GRAINS OF WATER/LB DRY AIR = 28.62

:::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
:::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	7.29	2.50	29.00	875.3	28.4(.0)	5.9(.0)	20.63	2.88	3.34	121.30	1004.27	6.22
40.0	7.29	2.50	29.00	811.2	28.8(.0)	6.4(.0)	22.26	1.98	6.10	23.07	1072.93	8.08
40.0	7.29	2.50	29.00	790.5	31.3(.0)	7.2(.0)	22.84	2.48	7.47	6.70	1068.93	9.94
40.0	7.29	2.50	29.00	760.8	34.6(.0)	8.3(.0)	23.73	4.35	3.04	6.63	1022.99	7.39
40.0	7.29	2.50	29.00	753.0	39.3(.0)	9.5(.0)	23.98	7.55	1.13	7.56	1001.99	8.68
40.0	7.29	2.50	29.00	781.4	48.3(.0)	11.2(.0)	23.11	18.17	.42	15.73	998.99	18.59

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 27-30 and 67-70

MIXTURE LOOP AT 40 REV/SEC 5.5 BAR BMEP

DATE 25/ 1/86   TEST NO. 41.0   BAROMETER 772.20 MM.HG   WET BULB TEMP(C) 9.5
DRY BULB TEMP(C) 17.0

RELATIVE HUMIDITY = 34.73
HUMIDITY CORRECTION FACTOR = .79
GRAINS OF WATER/LB DRY AIR = 28.62

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	16.03	5.50	63.80	647.6	46.7(.0)	5.9(.0)	27.88	2.53	6.20	84.29	750.53	8.73
40.0	16.03	5.50	63.80	602.6	47.3(.0)	6.4(.0)	29.96	2.02	12.01	17.33	795.21	14.03
40.0	16.03	5.50	63.80	584.2	50.3(.0)	7.1(.0)	30.91	1.94	14.86	3.87	791.31	16.80
40.0	16.03	5.50	63.80	569.5	57.7(.0)	8.3(.0)	31.70	3.69	6.88	5.04	764.54	10.57
40.0	16.03	5.50	63.80	558.6	63.9(.0)	9.3(.0)	32.32	5.14	2.26	5.42	744.93	7.41
40.0	16.03	5.50	63.80	565.1	73.7(.0)	10.6(.0)	31.95	7.44	.72	8.73	742.30	6.16

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 27-30 and 67-70

MIXTURE LOOP AT 40 REV/SEC 5.5 BAR BMEP

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
25	1	86	41.00	772.20	9.50	17.00	0	0.	4

1 ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00	40.00	40.00
28 IGNITION TIMING	11.00	13.00	14.50	17.00	20.00	26.00
4 FUEL VOLUME (CC)	203.00	203.00	203.00	203.00	203.00	203.00
2 BRAKE LOAD	63.80	63.80	63.80	63.80	63.80	63.80
5 FUEL TIME (SEC)	56.15	60.35	62.25	63.85	65.10	64.35
6 FUEL TEMPERATURE (C)	11.00	11.00	11.00	11.00	11.00	11.00
8 AIR METER TEMPERATURE (C)	13.00	13.00	13.00	14.00	15.00	15.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-236.88	-233.12	-208.30	-160.93	-115.06	-45.87
26 EXHAUST TEMP. (POST TURBO)	466.0	484.0	477.0	457.0	444.0	432.0
27 EXHAUST PRESSURE (POST TURBO)	20.3	21.8	21.8	25.6	28.6	33.8
13 CARBON MONOXIDE (%)	2.400	.500	.106	.117	.112	.157
15 CARBON DIOXIDE (%)	13.600	14.600	13.800	11.300	9.800	8.500
16 OXYGEN (%)	.200	.500	2.200	5.250	7.100	9.100
12 HYDROCARBONS (PPMC)	1260.0	1020.0	930.0	1500.0	1860.0	2340.0
14 OXIDES OF NITROGEN (PPM)	-1040.0	-2050.0	-2450.0	-1000.0	-300.0	-85.0

EPA/VW BRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

MIXTURE LOOP AT 40 REV/SEC 1.5 BAR BMEP

REFER TO FIGURE NOS. 19-22

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
25	1	86	42.00	772.20	9.50	17.00	0	0.	4

1	ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00	40.00	40.00
28	IGNITION TIMING	11.00	13.00	15.00	18.00	25.00	37.00
4	FUEL VOLUME (CC)	52.00	52.00	52.00	52.00	52.00	52.00
2	BRAKE LOAD	17.40	17.40	17.40	17.40	17.40	17.40
5	FUEL TIME (SEC)	29.70	32.50	33.30	33.95	34.45	33.95
6	FUEL TEMPERATURE (C)	11.00	12.00	12.00	12.00	12.00	12.00
8	AIR METER TEMPERATURE (C)	15.00	15.00	14.00	15.00	14.00	13.00
11	INTAKE MANIFOLD PRESS.(mm.Hg)	-479.78	-476.77	-463.98	-433.15	-406.08	-371.49
26	EXHAUST TEMP. (POST TURBO)	357.0	367.0	366.0	361.0	352.0	339.0
27	EXHAUST PRESSURE (POST TURBO)	6.0	6.8	6.8	7.5	9.0	10.5
13	CARBON MONOXIDE (%)	2.400	.500	.140	.122	.146	.196
15	CARBON DIOXIDE (%)	13.600	14.500	13.200	11.100	9.300	7.900
16	OXYGEN (%)	.200	.500	2.550	5.600	7.700	9.700
12	HYDROCARBONS (PPMC)	1020.0	660.0	780.0	1560.0	2475.0	4200.0
14	OXIDES OF NITROGEN (PPM)	-245.0	-480.0	-460.0	-140.0	-60.0	-33.0

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 19-22

MIXTURE LOOP AT 40 REV/SEC 1.5 BAR BMEP

DATE 25/ 1/86   TEST NO. 42.0   BAROMETER 772.20 MM.HG   WET BULB TEMP(C) 9.5
DRY BULB TEMP(C) 17.0

RELATIVE HUMIDITY = 34.73
HUMIDITY CORRECTION FACTOR = .79
GRAINS OF WATER/LB DRY AIR = 28.62

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	4.37	1.50	17.40	1150.0	22.8(.0)	5.9(.0)	15.70	3.64	2.60	149.91	1334.71	6.24
40.0	4.37	1.50	17.40	1050.0	22.6(.0)	6.4(.0)	17.19	2.30	4.94	30.47	1368.59	7.24
40.0	4.37	1.50	17.40	1024.8	24.6(.0)	7.2(.0)	17.62	2.98	5.06	9.35	1365.26	8.04
40.0	4.37	1.50	17.40	1005.2	28.4(.0)	8.4(.0)	17.96	6.89	1.72	9.43	1347.43	8.61
40.0	4.37	1.50	17.40	990.6	31.9(.0)	9.7(.0)	18.23	12.65	.83	13.05	1305.87	13.47
40.0	4.37	1.50	17.40	1005.2	36.6(.0)	11.0(.0)	17.96	24.79	.51	20.23	1261.27	25.30

EPA/VW HRCC METHANOL (79.5mm x 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

MIXTURE LOOP AT 60 REV/SEC 2.5 BAR BMEP

REFER TO FIGURE NOS. 31-34

DATE 26/ 1/86 TEST NO. 43.0 BAROMETER 772.15 MM.HG WET BULB TEMP(C) 12.0
DRY BULB TEMP(C) 22.0

RELATIVE HUMIDITY = 27.10
HUMIDITY CORRECTION FACTOR = .80
GRAINS OF WATER/LB DRY AIR = 30.48

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)		AIR FUEL RATIO		B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
60.0	10.93	2.50	29.00	906.4	29.4(	.0)	5.9(	.0)	19.92	2.55	6.46	118.97	1051.48	9.01
60.0	10.93	2.50	29.00	846.7	30.0(	.0)	6.5(	.0)	21.32	1.61	9.29	24.75	1120.12	10.90
60.0	10.93	2.50	29.00	812.4	32.0(	.0)	7.2(	.0)	22.22	1.84	10.73	8.07	1098.61	12.58
60.0	10.93	2.50	29.00	794.3	36.3(	.0)	8.3(	.0)	22.73	3.99	5.14	7.78	1068.22	9.13
60.0	10.93	2.50	29.00	788.4	40.5(	.0)	9.4(	.0)	22.90	6.34	1.57	7.53	1054.09	7.91
60.0	10.93	2.50	29.00	826.9	50.9(	.0)	11.2(	.0)	21.83	17.80	.53	17.30	1060.14	18.33

EPA/VW UREE METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 31-34

MIXTURE LOOP AT 60 REV/SEC 2.5 BAR BMEP

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
26	1	86	43.00	772.15	12.00	22.00	0	0.	4

1 ENGINE SPEED (REV/S)	60.00	60.00	60.00	60.00	60.00	60.00
28 IGNITION TIMING	16.00	17.50	20.00	22.00	25.00	41.00
4 FUEL VOLUME (CC)	203.00	203.00	203.00	203.00	203.00	203.00
2 BRAKE LOAD	29.00	29.00	29.00	29.00	29.00	29.00
5 FUEL TIME (SEC)	58.90	63.05	65.65	67.15	67.65	64.50
6 FUEL TEMPERATURE (C)	10.00	10.00	11.00	11.00	11.00	11.00
8 AIR METER TEMPERATURE (C)	10.00	11.00	11.00	11.00	10.00	10.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-424.13	-418.86	-405.33	-373.74	-341.41	-272.22
26 EXHAUST TEMP. (POST TURBO)	472.0	491.0	483.0	468.0	454.0	427.0
27 EXHAUST PRESSURE (POST TURBO)	20.3	22.6	21.8	24.8	28.6	37.6
13 CARBON MONOXIDE (%)	2.400	.500	.150	.127	.110	.200
15 CARBON DIOXIDE (%)	13.500	14.400	13.000	11.100	9.800	7.800
16 OXYGEN (%)	.200	.500	2.400	5.200	7.200	10.000
12 HYDROCARBONS (PPMC)	900.0	570.0	600.0	1140.0	1620.0	3600.0
14 OXIDES OF NITROGEN (PPM)	-760.0	-1100.0	-1200.0	-520.0	-145.0	-40.0

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS **REFER TO FIGURE NOS. 35-38**

MIXTURE LOOP AT 60 REV/SEC 5.5 BAR BMEP

DATE 26/ 1/86   TEST NO. 44.0   BAROMETER 772.15 MM.HG   WET BULB TEMP(C) 12.0
DRY BULB TEMP(C) 22.0

RELATIVE HUMIDITY = 27.10
HUMIDITY CORRECTION FACTOR = .80
GRAINS OF WATER/LB DRY AIR = 30.48

:::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
:::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
60.0	24.05	5.50	63.80	649.7	46.5(.0)	5.9(.0)	27.79	1.88	6.97	88.26	748.86	8.85
60.0	24.05	5.50	63.80	604.4	47.3(.0)	6.4(.0)	29.87	1.37	12.51	20.91	793.84	13.89
60.0	24.05	5.50	63.80	584.7	50.5(.0)	7.1(.0)	30.88	1.04	13.88	3.96	794.36	14.92
60.0	24.05	5.50	63.80	563.7	57.0(.0)	8.4(.0)	32.03	2.15	6.28	5.31	760.27	8.43
60.0	24.05	5.50	63.80	566.3	64.6(.0)	9.4(.0)	31.88	3.72	2.18	5.28	759.61	5.90
60.0	24.05	5.50	63.80	573.1	74.4(.0)	10.7(.0)	31.50	6.42	.66	7.83	757.59	7.08

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS 35-38

MIXTURE LOOP AT 60 REV/SEC 5.5 BAR BMEP

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
26	1	86	44.00	772.15	12.00	22.00	0	0.	4

1 ENGINE SPEED (REV/S)	60.00	60.00	60.00	60.00	60.00	60.00
28 IGNITION TIMING	15.00	16.00	18.00	21.00	24.50	33.50
4 FUEL VOLUME (CC)	203.00	203.00	203.00	203.00	203.00	203.00
2 BRAKE LOAD	63.80	63.80	63.80	63.80	63.80	63.80
5 FUEL TIME (SEC)	37.35	40.15	41.50	43.05	42.85	42.30
6 FUEL TEMPERATURE (C)	10.00	10.00	10.00	10.00	10.00	11.00
8 AIR METER TEMPERATURE (C)	10.00	12.00	12.00	11.00	12.00	12.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-261.70	-254.93	-228.61	-178.22	-130.10	-60.91
26 EXHAUST TEMP. (POST TURBO)	546.0	570.0	562.0	531.0	505.0	485.0
27 EXHAUST PRESSURE (POST TURBO)	43.6	45.9	47.4	54.1	60.9	72.9
13 CARBON MONOXIDE (%)	2.500	.600	.105	.123	.107	.138
15 CARBON DIOXIDE (%)	13.500	14.500	13.400	11.200	9.800	8.500
16 OXYGEN (%)	.300	.550	2.200	5.300	7.150	9.100
12 HYDROCARBONS (PPMC)	930.0	690.0	480.0	870.0	1320.0	1980.0
14 OXIDES OF NITROGEN (PPM)	-1150.0	-2100.0	-2200.0	-900.0	-280.0	-75.0

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

MIXTURE LOOP AT 60 REV/SEC 7.0 BAR BMEP

REFER TO FIGURE NOS. 39-42

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
26	1	86	45.00	772.15	12.00	22.00	0	0.	4

1	ENGINE SPEED (REV/S)	60.00	60.00	60.00	60.00	60.00	60.00
28	IGNITION TIMING	15.00	16.00	16.50	18.50	23.00	29.00
4	FUEL VOLUME (CC)	304.00	304.00	304.00	304.00	304.00	304.00
2	BRAKE LOAD	81.20	81.20	81.20	81.20	81.20	81.20
5	FUEL TIME (SEC)	47.05	50.55	52.55	54.10	53.65	53.15
6	FUEL TEMPERATURE (C)	11.00	11.00	11.00	11.00	11.00	11.00
8	AIR METER TEMPERATURE (C)	12.00	13.00	13.00	13.00	13.00	13.00
11	INTAKE MANIFOLD PRESS.(mm.Hg)	-178.98	-169.20	-136.86	-82.72	-37.60	-6.02
26	EXHAUST TEMP. (POST TURBO)	575.0	596.0	582.0	554.0	526.0	513.0
27	EXHAUST PRESSURE (POST TURBO)	57.9	61.7	64.7	73.7	81.2	88.0
13	CARBON MONOXIDE (%)	2.200	.600	.100	.112	.111	.116
15	CARBON DIOXIDE (%)	13.500	14.600	13.200	11.500	10.200	9.500
16	OXYGEN (%)	.200	.500	2.400	4.900	6.600	7.700
12	HYDROCARBONS (PPMC)	900.0	600.0	420.0	720.0	1140.0	1560.0
14	OXIDES OF NITROGEN (PPM)	-1300.0	-2300.0	-2350.0	-1100.0	-480.0	-235.0

EPA/VW HPCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 39-42

MIXTURE LOOP AT 60 REV/SEC 7.0 BAR BMEP

DATE 26/ 1/86   TEST NO. 45.0   BAROMETER 772.15 MM.HG   WET BULB TEMP(C) 12.0
DRY BULB TEMP(C) 22.0

RELATIVE HUMIDITY = 27.10
HUMIDITY CORRECTION FACTOR = .89
GRAINS OF WATER/LB DRY AIR = 30.48

: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :

RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
60.0	30.61	7.00	81.20	606.3	55.9(.0)	6.0(.0)	29.78	1.73	7.47	73.88	712.27	9.20
60.0	30.61	7.00	81.20	564.3	56.3(.0)	6.4(.0)	31.99	1.11	12.74	19.40	741.88	13.85
60.0	30.61	7.00	81.20	542.8	60.5(.0)	7.2(.0)	33.26	.85	13.94	3.56	737.97	14.79
60.0	30.61	7.00	81.20	527.3	66.9(.0)	8.2(.0)	34.24	1.62	7.04	4.42	713.12	8.67
60.0	30.61	7.00	81.20	531.7	74.8(.0)	9.1(.0)	33.96	2.91	3.40	4.95	714.84	6.31
60.0	30.61	7.00	81.20	536.7	80.7(.0)	9.7(.0)	33.64	4.28	1.77	5.57	716.96	6.06

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

MIXTURE LOOP AT 15 REV/SEC IDLE

REFER TO FIGURE NOS. 43-46 and 71-74

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
26	1	86	46.00	772.15	12.00	22.00	0	0.	4

1 ENGINE SPEED (REV/S)	15.00	15.00	15.00	15.00	15.00
28 IGNITION TIMING	20.00	20.00	20.00	20.00	20.00
4 FUEL VOLUME (CC)	52.00	52.00	52.00	52.00	52.00
2 BRAKE LOAD	.00	.00	.00	.00	.00
5 FUEL TIME (SEC)	133.80	142.76	149.95	149.30	147.80
6 FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00	12.00
8 AIR METER TEMPERATURE (C)	24.00	23.00	22.00	23.00	23.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-538.43	-538.43	-533.92	-515.87	-498.58
26 EXHAUST TEMP. (POST TURBO)	150.0	118.0	116.0	119.0	129.0
27 EXHAUST PRESSURE (POST TURBO)	.0	.0	.0	.0	.0
13 CARBON MONOXIDE (%)	2.450	1.200	.400	.208	.245
15 CARBON DIOXIDE (%)	13.300	13.600	13.400	11.600	9.800
16 OXYGEN (%)	.750	1.200	2.200	4.900	6.900
12 HYDROCARBONS (PPMC)	3150.0	3060.0	3000.0	4200.0	5700.0
14 OXIDES OF NITROGEN (PPM)	-28.0	-31.0	-28.0	-22.0	-14.0

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 43-46 and 71-74

MIXTURE LOOP AT 15 REV/SEC IDLE

DATE 26/ 1/86 TEST NO. 46.0 BAROMETER 772.15 MM.HG WET BULB TEMP(C) 12.0
DRY BULB TEMP(C) 22.0

RELATIVE HUMIDITY = 27.10
HUMIDITY CORRECTION FACTOR = .80
GRAINS OF WATER/LB DRY-AIR = 30.48

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
15.0	.00	.00	.00	1115.3	14.0(.0)	6.0(.0)	.00	10.93	.29	148.75	1268.90	11.23
15.0	.00	.00	.00	1045.8	14.0(.0)	6.4(.0)	.00	10.59	.32	72.65	1293.73	10.91
15.0	.00	.00	.00	995.2	14.3(.0)	6.9(.0)	.00	10.59	.29	24.69	1299.62	10.88
15.0	.00	.00	.00	999.5	16.5(.0)	7.9(.0)	.00	17.17	.26	14.87	1302.93	17.42
15.0	.00	.00	.00	1009.7	18.7(.0)	8.8(.0)	.00	27.11	.18	20.38	1260.88	27.29

EPA/VW BRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 51-54

IGNITION TIMING SWING AT 40 REV/SEC 2.5 BAR BMEP

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
26	1	86	47.00	760.41	14.50	22.00	0	0.	4

1 ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00	40.00	40.00	40.00
28 IGNITION TIMING	35.00	30.00	25.00	20.00	15.00	10.00	5.00
4 FUEL VOLUME (CC)	102.50	102.50	102.50	102.50	102.50	102.50	102.50
2 BRAKE LOAD	29.00	29.00	29.00	29.00	29.00	29.00	29.00
5 FUEL TIME (SEC)	51.70	52.30	52.75	53.05	52.95	52.25	50.60
6 FUEL TEMPERATURE (C)	11.00	12.00	12.00	12.00	12.00	12.00	12.00
8 AIR METER TEMPERATURE (C)	17.00	17.00	18.00	18.00	18.00	18.00	18.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-353.44	-354.94	-356.45	-356.45	-355.70	-354.94	-346.67
26 EXHAUST TEMP. (POST TURBO)	388.0	386.0	384.0	384.0	387.0	397.0	415.0
27 EXHAUST PRESSURE (POST TURBO)	12.0	12.0	12.0	11.3	12.0	12.0	12.0
13 CARBON MONOXIDE (%)	.130	.128	.124	.120	.114	.104	.092
15 CARBON DIOXIDE (%)	11.300	11.300	11.300	11.200	11.300	11.300	11.300
16 OXYGEN (%)	4.900	5.000	5.000	5.000	5.000	4.900	4.900
12 HYDROCARBONS (PPMC)	1380.0	1320.0	1350.0	1380.0	1380.0	1260.0	1200.0
14 OXIDES OF NITROGEN (PPM)	-800.0	-700.0	-510.0	-390.0	-300.0	-240.0	-140.0

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS **REFER TO FIGURE NOS. 51-54**

IGNITION TIMING SWING AT 40 REV/SEC 2.5 BAR BMEP

DATE 26/ 1/86 TEST NO. 47.0 BAROMETER 760.41 MM.HG WET BULB TEMP(C) 14.5
DRY BULB TEMP(C) 22.0

RELATIVE HUMIDITY = 43.29
HUMIDITY CORRECTION FACTOR = .90
GRAINS OF WATER/LB DRY AIR = 49.66

:::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
:::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	7.29	2.50	29.00	781.4	36.3(.0)	8.2(.0)	23.11	4.60	8.54	7.63	1048.78	13.20
40.0	7.29	2.50	29.00	771.7	36.1(.0)	8.2(.0)	23.40	4.41	7.38	7.47	1036.52	11.79
40.0	7.29	2.50	29.00	765.1	35.9(.0)	8.2(.0)	23.60	4.47	5.33	7.18	1027.77	9.80
40.0	7.29	2.50	29.00	760.8	35.7(.0)	8.2(.0)	23.73	4.58	4.08	6.97	1021.84	8.67
40.0	7.29	2.50	29.00	762.2	35.8(.0)	8.2(.0)	23.69	4.55	3.13	6.58	1024.51	7.68
40.0	7.29	2.50	29.00	772.4	36.1(.0)	8.2(.0)	23.37	4.22	2.54	6.09	1040.21	6.76
40.0	7.29	2.50	29.00	797.6	37.3(.0)	8.2(.0)	22.64	4.16	1.53	5.57	1075.81	5.69

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.F.C./BOSCH IGNITION - CORRECT INJECTORS

IGNITION TIMING SWING AT 40 REV/SEC 5.5 BAR BMEP

REFER TO FIGURE NOS. 55-58

DATE 27/ 1/86 TEST NO. 48.0 BAROMETER 760.41 MM.HG WET BULB TEMP(C) 14.5
DRY BULB TEMP(C) 22.0

RELATIVE HUMIDITY = 43.29
HUMIDITY CORRECTION FACTOR = .90
GRAINS OF WATER/LB DRY AIR = 49.66

:::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
:::

RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	16.03	5.50	63.80	572.6	58.4(.0)	8.1(.0)	31.53	3.94	17.73	4.76	763.51	21.67
40.0	16.03	5.50	63.80	571.7	59.0(.0)	8.2(.0)	31.58	3.93	12.87	5.18	766.66	16.80
40.0	16.03	5.50	63.80	570.4	58.5(.0)	8.2(.0)	31.65	3.91	10.89	5.38	764.52	14.81
40.0	16.03	5.50	63.80	569.5	58.7(.0)	8.2(.0)	31.70	3.87	9.32	5.37	763.42	13.19
40.0	16.03	5.50	63.80	568.1	58.5(.0)	8.2(.0)	31.78	3.86	7.60	5.36	761.63	11.46
40.0	16.03	5.50	63.80	569.9	58.7(.0)	8.2(.0)	31.68	3.84	6.53	5.38	764.12	10.37
40.0	16.03	5.50	63.80	575.8	58.9(.0)	8.1(.0)	31.36	3.85	4.60	5.22	772.42	8.45
40.0	16.03	5.50	63.80	583.2	59.7(.0)	8.1(.0)	30.96	3.86	3.01	4.94	762.98	6.87

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 55-58

IGNITION TIMING SWING AT 40 REV/SEC 5.5 BAR BMEP

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
27	1	86	48.00	760.41	14.50	22.00	0	0.	4

1 ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
28 IGNITION TIMING	35.00	30.00	25.00	20.00	17.00	15.00	10.00	5.00
4 FUEL VOLUME (CC)	203.00	203.00	203.00	203.00	203.00	203.00	203.00	203.00
2 BRAKE LOAD	63.80	63.80	63.80	63.80	63.80	63.80	63.80	63.80
5 FUEL TIME (SEC)	63.45	63.55	63.70	63.80	63.95	63.75	63.10	62.30
6 FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
8 AIR METER TEMPERATURE (C)	17.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-145.14	-148.14	-149.65	-150.40	-150.40	-149.65	-145.89	-137.62
26 EXHAUST TEMP. (POST TURBO)	461.0	458.0	456.0	453.0	454.0	458.0	468.0	489.0
27 EXHAUST PRESSURE (POST TURBO)	25.6	25.6	26.3	25.6	25.6	25.6	26.3	27.8
13 CARBON MONOXIDE (%)	.112	.120	.125	.125	.125	.125	.121	.113
15 CARBON DIOXIDE (%)	11.500	11.300	11.300	11.300	11.300	11.300	11.400	11.400
16 OXYGEN (%)	4.900	5.000	4.900	5.000	5.000	5.000	4.900	4.900
12 HYDROCARBONS (PPMC)	1620.0	1590.0	1590.0	1575.0	1575.0	1560.0	1560.0	1545.0
14 OXIDES OF NITROGEN (PPM)	-2300.0	-1650.0	-1400.0	-1200.0	-980.0	-840.0	-590.0	-380.0

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 47-50 and 75-78

IGNITION TIMING SWING AT 15 REV/SEC IDLE

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
27	1	86	49.00	756.36	14.50	22.00	0	0.	4

1 ENGINE SPEED (REV/S)	15.00	15.00	15.00	15.00	15.00	15.00
28 IGNITION TIMING	30.00	25.00	20.00	15.00	10.00	5.00
4 FUEL VOLUME (CC)	52.00	52.00	52.00	52.00	52.00	52.00
2 BRAKE LOAD	.00	.00	.00	.00	.00	.00
5 FUEL TIME (SEC)	142.80	143.50	144.10	143.55	142.65	141.50
6 FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00	12.00	12.00
8 AIR METER TEMPERATURE (C)	24.00	24.00	24.00	24.00	24.00	24.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-524.90	-524.90	-527.15	-526.40	-524.14	-521.14
26 EXHAUST TEMP. (POST TURBO)	121.0	118.0	113.0	112.0	114.0	121.0
27 EXHAUST PRESSURE (POST TURBO)	.0	.0	.0	.0	.0	.0
13 CARBON MONOXIDE (%)	1.300	1.200	1.300	1.200	1.200	1.100
15 CARBON DIOXIDE (%)	13.500	13.500	13.500	13.500	13.600	13.600
16 OXYGEN (%)	1.200	1.300	1.300	1.350	1.300	1.200
12 HYDROCARBONS (PPMC)	3600.0	3300.0	3150.0	3060.0	2940.0	2400.0
14 OXIDES OF NITROGEN (PPM)	-30.0	-28.0	-24.0	-22.0	-20.0	-18.0

EPA/VW DRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

IGNITION TIMING SWING AT 15 REV/SEC IDLE

REFER TO FIGURE NOS. 47-50 and 75-78

DATE 27/ 1/86 TEST NO. 49.0 BAROMETER 756.36 MM.HG WET BULB TEMP(C) 14.5
DRY BULB TEMP(C) 22.0

RELATIVE HUMIDITY = 43.39
HUMIDITY CORRECTION FACTOR = .90
GRAINS OF WATER/LB DRY AIR = 50.05

: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :

RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)		AIR FUEL RATIO		B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
15.0	.00	.00	.00	1045.0	14.2(	.0)	6.3(	.0)	.00	12.41	.34	78.37	1278.74	12.75
15.0	.00	.00	.00	1039.9	14.3(	.0)	6.4(	.0)	.00	11.42	.32	72.61	1285.51	11.74
15.0	.00	.00	.00	1035.6	14.2(	.0)	6.4(	.0)	.00	10.79	.27	77.90	1270.98	11.06
15.0	.00	.00	.00	1039.6	14.3(	.0)	6.4(	.0)	.00	10.60	.25	72.70	1285.12	10.85
15.0	.00	.00	.00	1046.1	14.4(	.0)	6.4(	.0)	.00	10.19	.23	72.74	1295.21	10.42
15.0	.00	.00	.00	1054.6	14.6(	.0)	6.4(	.0)	.00	8.47	.21	67.91	1319.19	8.68

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 83-86

E.G.R. LOOP AT 40 REV/SEC 2.5 BAR BMEP 1.0 E.R.

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
30	1	86	51.00	749.61	10.00	14.50	0	0.	4

1 ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00	40.00	40.00	40.00
28 IGNITION TIMING	11.00	14.00	17.00	21.00	24.00	27.00	29.00
4 FUEL VOLUME (CC)	102.50	102.50	102.50	102.50	102.50	102.50	102.50
2 BRAKE LOAD	29.00	29.00	29.00	29.00	29.00	29.00	29.00
5 FUEL TIME (SEC)	49.85	51.10	51.00	50.50	49.65	49.15	48.80
6 FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00	12.00	12.00	12.00
8 AIR METER TEMPERATURE (C)	18.00	19.00	20.00	20.00	20.00	17.00	17.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-392.54	-373.74	-341.41	-317.34	-280.50	-245.15	-215.07
26 EXHAUST TEMP. (POST TURBO)	397.0	397.0	395.0	388.0	384.0	383.0	381.0
27 EXHAUST PRESSURE (POST TURBO)	9.8	9.8	9.8	9.0	9.0	9.0	9.0
13 CARBON MONOXIDE (%)	.550	.600	.500	.600	.600	.650	.700
15 CARBON DIOXIDE (%)	14.500	14.600	14.600	14.500	14.600	14.600	14.500
16 OXYGEN (%)	.500	.500	.600	.650	.700	.700	.800
12 HYDROCARBONS (PPMC)	720.0	840.0	1080.0	1440.0	1740.0	1950.0	2280.0
14 OXIDES OF NITROGEN (PPM)	-780.0	-360.0	-180.0	-100.0	-55.0	-36.0	-23.0
17 INTAKE MANIFOLD CO2 (%)	.030	.870	1.690	2.320	2.980	3.540	3.980
30 AMBIENT CO2 (%)	.030	.030	.030	.030	.030	.030	.030

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.F.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 83-86

E.G.R. LOOP AT 40 REV/SEC 2.5 BAR BMEP 1.0 E.R.

DATE 30/ 1/86 TEST NO. 51.0 BAROMETER 749.61 MM.HG WET BULB TEMP(C) 10.0
DRY BULB TEMP(C) 14.5

RELATIVE HUMIDITY = 56.22
HUMIDITY CORRECTION FACTOR = .85
GRAINS OF WATER/LB DRY AIR = 40.78

:::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
:::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	7.29	2.50	29.00	809.6	30.2(.0)	6.4(.0)	22.30	1.93	6.65	25.75	1066.73	8.57
40.0	7.29	2.50	29.00	789.8	29.5(.0)	6.4(.0)	22.86	2.17	2.97	27.12	1036.70	5.14
40.0	7.29	2.50	29.00	791.4	29.8(.0)	6.5(.0)	22.81	2.81	1.49	22.75	1043.93	4.30
40.0	7.29	2.50	29.00	799.2	30.0(.0)	6.4(.0)	22.59	3.77	.83	27.51	1044.57	4.61
40.0	7.29	2.50	29.00	812.9	30.5(.0)	6.4(.0)	22.21	4.60	.46	27.74	1060.73	5.06
40.0	7.29	2.50	29.00	821.1	30.4(.0)	6.4(.0)	21.99	5.18	.31	30.22	1066.60	5.49
40.0	7.29	2.50	29.00	827.0	30.7(.0)	6.4(.0)	21.83	6.11	.20	32.82	1068.07	6.31

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 87-90

E.G.R. LOOP AT 40 REV/SEC 5.5 BAR BMEP 1.0 E.R.

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
31	1	86	52.00	753.60	10.00	14.50	0	0.	4

1	ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00
28	IGNITION TIMING	12.00	14.00	16.00	19.00
4	FUEL VOLUME (CC)	203.00	203.00	203.00	203.00
2	BRAKE LOAD	63.80	63.80	63.80	63.80
5	FUEL TIME (SEC)	60.30	61.05	61.35	61.40
6	FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00
8	AIR METER TEMPERATURE (C)	17.00	18.00	18.00	18.00
11	INTAKE MANIFOLD PRESS.(mm.Hg)	-214.32	-184.24	-132.35	-98.51
26	EXHAUST TEMP. (POST TURBO)	483.0	476.0	470.0	468.0
27	EXHAUST PRESSURE (POST TURBO)	22.6	21.8	21.8	21.1
13	CARBON MONOXIDE (%)	.500	.500	.600	.600
15	CARBON DIOXIDE (%)	14.600	14.700	14.500	14.500
16	OXYGEN (%)	.500	.500	.600	.600
12	HYDROCARBONS (PPMC)	1140.0	1620.0	1740.0	1830.0
14	OXIDES OF NITROGEN (PPM)	-2000.0	-1400.0	-740.0	-550.0
17	INTAKE MANIFOLD CO2 (%)	.040	.770	1.460	1.890
30	AMBIENT CO2 (%)	.040	.040	.040	.040

EPA/VW HPCC METHANOL (79.5mm x 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 87-90

E.G.R. LOOP AT 40 REV/SEC 5.5 BAR BMEP 1.0 E.R.

DATE 31/ 1/86 TEST NO. 52.0 BAROMETER 753.60 MM.HG WET BULB TEMP(C) 10.0
DRY BULB TEMP(C) 14.5

RELATIVE HUMIDITY = 56.12
HUMIDITY CORRECTION FACTOR = .85
GRAINS OF WATER/LB DRY AIR = 40.49

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.I.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	16.03	5.50	63.80	602.5	49.1(.0)	6.4(.0)	29.96	2.26	12.60	17.32	794.51	14.86
40.0	16.03	5.50	63.80	595.1	48.4(.0)	6.4(.0)	30.34	3.14	8.64	16.94	782.52	11.78
40.0	16.03	5.50	63.80	592.2	48.2(.0)	6.4(.0)	30.49	3.37	4.56	20.34	772.52	7.93
40.0	16.03	5.50	63.80	591.7	48.1(.0)	6.4(.0)	30.51	3.54	3.39	20.32	771.44	6.93

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.F.C./BOSCH IGNITION - CORRECT INJECTORS

E.G.R. LOOP AT 40 REV/SEC 5.5 BAR BMEP 0.9 E.R.

REFER TO FIGURE NOS. 87-90

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
31	1	86	53.00	752.31	11.00	19.00	0	0.	4

1	ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00
28	IGNITION TIMING	14.00	15.00	16.00	17.00
4	FUEL VOLUME (CC)	203.00	203.00	203.00	203.00
2	BRAKE LOAD	63.80	63.80	63.80	63.80
5	FUEL TIME (SEC)	63.25	63.55	64.25	63.80
6	FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00
8	AIR METER TEMPERATURE (C)	16.00	16.00	17.00	16.00
11	INTAKE MANIFOLD PRESS.(mm.Hg)	-191.76	-159.42	-118.82	-90.24
26	EXHAUST TEMP. (POST TURBO)	472.0	464.0	466.0	461.0
27	EXHAUST PRESSURE (POST TURBO)	22.6	22.6	22.6	21.8
13	CARBON MONOXIDE (%)	.127	.138	.148	.152
15	CARBON DIOXIDE (%)	13.300	13.300	13.300	13.300
16	OXYGEN (%)	2.500	2.500	2.400	2.500
12	HYDROCARBONS (PPMC)	1200.0	1440.0	1680.0	1830.0
14	OXIDES OF NITROGEN (PPM)	-2250.0	-1250.0	-780.0	-580.0
17	INTAKE MANIFOLD CO2 (%)	.040	.600	1.210	1.500
30	AMBIENT CO2 (%)	.040	.040	.040	.040

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

E.G.R. LOOP AT 40 REV/SEC 5.5 BAR BMEP 0.9 E.R.

REFER TO FIGURE NOS. 87-90

DATE 31/ 1/86 TEST NO. 53.0 BAROMETER 752.31 MM.HG WET BULB TEMP(C) 11.0
DRY BULB TEMP(C) 19.0

RELATIVE HUMIDITY = 35.41
HUMIDITY CORRECTION FACTOR = .82
GRAINS OF WATER/LB DRY AIR = 34.00

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::

RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	16.03	5.50	63.80	574.4	52.0(.0)	7.2(.0)	31.43	2.54	14.25	4.71	774.92	16.79
40.0	16.03	5.50	63.80	571.7	51.6(.0)	7.1(.0)	31.58	3.03	7.86	5.08	769.28	10.89
40.0	16.03	5.50	63.80	565.5	50.8(.0)	7.1(.0)	31.93	3.49	4.84	5.38	758.99	8.33
40.0	16.03	5.50	63.80	569.5	51.2(.0)	7.1(.0)	31.70	3.82	3.62	5.55	763.28	7.44

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 87-90

E.G.R. LOOP AT 40 REV/SEC 5.5 BAR BMEP 0.8 E.R.

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
1	2	86	54.00	753.70	12.00	18.00	0	0.	4

1	ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00
28	IGNITION TIMING	16.00	17.00	19.00	20.00
4	FUEL VOLUME (CC)	203.00	203.00	203.00	203.00
2	BRAKE LOAD	63.80	63.80	63.80	63.80
5	FUEL TIME (SEC)	64.05	64.35	64.50	64.55
6	FUEL TEMPERATURE (C)	10.00	10.00	11.00	11.00
8	AIR METER TEMPERATURE (C)	14.00	16.00	16.00	16.00
11	INTAKE MANIFOLD PRESS.(mm.Hg)	-153.41	-121.07	-88.74	-74.45
26	EXHAUST TEMP. (POST TURBO)	458.0	454.0	452.0	448.0
27	EXHAUST PRESSURE (POST TURBO)	25.6	24.8	24.8	24.8
13	CARBON MONOXIDE (%)	.133	.139	.148	.145
15	CARBON DIOXIDE (%)	11.700	11.700	11.700	11.600
16	OXYGEN (%)	4.600	4.700	4.700	4.700
12	HYDROCARBONS (PPMC)	1620.0	1800.0	1980.0	2070.0
14	OXIDES OF NITROGEN (PPM)	-1150.0	-680.0	-480.0	-430.0
17	INTAKE MANIFOLD CO2 (%)	.020	.500	.860	.950
30	AMBIENT CO2 (%)	.020	.020	.020	.020

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 87-90

E.G.R. LOOP AT 40 REV/SEC 5.5 BAR BMEP 0.8 E.R.

DATE 1/ 2/86 TEST NO. 54.0 BAROMETER 753.70 MM.HG WET BULB TEMP(C) 12.0
DRY BULB TEMP(C) 18.0

RELATIVE HUMIDITY = 48.49
HUMIDITY CORRECTION FACTOR = .87
GRAINS OF WATER/LB DRY AIR = 43.76

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::

RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	16.03	5.50	63.80	568.3	56.8(.0)	8.0(.0)	31.77	3.84	8.40	5.51	761.67	12.24
40.0	16.03	5.50	63.80	565.6	57.0(.0)	8.0(.0)	31.92	4.24	4.93	5.72	756.60	9.17
40.0	16.03	5.50	63.80	563.8	56.7(.0)	8.0(.0)	32.02	4.63	3.46	6.06	752.47	8.10
40.0	16.03	5.50	63.80	563.4	56.7(.0)	8.0(.0)	32.05	4.88	3.12	5.98	751.32	8.00

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

E.G.R. LOOP AT 40 REV/SEC 5.5 BAR BMEP 0.7 E.R.

REFER TO FIGURE NOS. 87-90

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
1	2	86	55.00	753.70	12.00	18.00	0	0.	4

1 ENGINE SPEED (REV/S)	40.00	40.00	40.00
28 IGNITION TIMING	20.00	20.00	21.00
4 FUEL VOLUME (CC)	203.00	203.00	203.00
2 BRAKE LOAD	63.80	63.80	63.80
5 FUEL TIME (SEC)	65.05	65.20	65.30
6 FUEL TEMPERATURE (C)	11.00	11.00	11.00
8 AIR METER TEMPERATURE (C)	16.00	16.00	16.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-103.78	-84.22	-48.13
26 EXHAUST TEMP. (POST TURBO)	441.0	439.0	436.0
27 EXHAUST PRESSURE (POST TURBO)	29.3	28.6	28.6
13 CARBON MONOXIDE (%)	.125	.124	.125
15 CARBON DIOXIDE (%)	9.900	9.900	9.900
16 OXYGEN (%)	6.900	6.900	7.000
12 HYDROCARBONS (PPMC)	2100.0	2190.0	2280.0
14 OXIDES OF NITROGEN (PPM)	-290.0	-200.0	-125.0
17 INTAKE MANIFOLD CO2 (%)	.030	.300	.570
30 AMBIENT CO2 (%)	.030	.030	.030

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURES 87-90

E.G.R. LOOP AT 40 REV/SEC 5.5 BAR BMEP 0.7 E.R.

DATE 1/ 2/86 TEST NO. 55.0 BAROMETER 753.70 MM.HG WET BULB TEMP(C) 12.0
DRY BULB TEMP(C) 18.0

RELATIVE HUMIDITY = 48.49
HUMIDITY CORRECTION FACTOR = .87
GRAINS OF WATER/LB DRY AIR = 43.76

: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :

RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	16.03	5.50	63.80	559.0	64.7(.0)	9.2(.0)	32.30	5.73	2.37	5.97	743.03	8.11
40.0	16.03	5.50	63.80	557.8	64.5(.0)	9.2(.0)	32.37	5.96	1.63	5.90	740.74	7.59
40.0	16.03	5.50	63.80	556.9	64.6(.0)	9.2(.0)	32.42	6.19	1.02	5.94	738.86	7.21

EPA/VW HRCC METHANOL (79.5mm x 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 83-86

E.G.R. LOOP AT 40 REV/SEC 2.5 BAR BMEP 0.9 F.R.

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
1	2	86	56.00	753.70	12.00	16.00	0	0.	4

1 ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00	40.00	40.00	40.00
28 IGNITION TIMING	13.00	15.00	17.00	21.00	24.00	27.00	29.00
4 FUEL VOLUME (CC)	102.50	102.50	102.50	102.50	102.50	102.50	102.50
2 BRAKE LOAD	29.00	29.00	29.00	29.00	29.00	29.00	29.00
5 FUEL TIME (SEC)	51.05	51.65	52.20	51.75	51.30	51.00	50.65
6 FUEL TEMPERATURE (C)	11.00	11.00	11.00	11.00	11.00	11.00	11.00
8 AIR METER TEMPERATURE (C)	17.00	17.00	17.00	17.00	17.00	17.00	17.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-382.02	-358.70	-330.13	-300.05	-270.72	-242.90	-203.79
26 EXHAUST TEMP. (POST TURBO)	395.0	392.0	389.0	383.0	381.0	378.0	380.0
27 EXHAUST PRESSURE (POST TURBO)	9.8	9.8	9.0	9.0	9.0	9.0	9.0
13 CARBON MONOXIDE (%)	.140	.138	.132	.142	.147	.160	.184
15 CARBON DIOXIDE (%)	13.200	13.300	13.200	13.200	13.200	13.300	13.200
16 OXYGEN (%)	2.500	2.400	2.500	2.450	2.500	2.500	2.500
12 HYDROCARBONS (PPMC)	840.0	1020.0	1320.0	1680.0	1950.0	2160.0	2640.0
14 OXIDES OF NITROGEN (PPM)	-820.0	-340.0	-190.0	-125.0	-90.0	-64.0	-38.0
17 INTAKE MANIFOLD CO2 (%)	.030	.780	1.400	2.020	2.480	2.910	3.260
30 AMBIENT CO2 (%)	.030	.030	.030	.030	.030	.030	.030

EPA/VW HRCC METHANOL (79.5mm x 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

E.G.R. LOOP AT 40 REV/SEC 2.5 BAR BMEP 0.9 E.R.

REFER TO FIGURE NOS. 83-86

DATE 1/ 2/86 TEST NO. 56.0 BAROMETER 753.70 MM.HG WET BULB TEMP(C) 12.0
DRY BULB TEMP(C) 18.0

RELATIVE HUMIDITY = 48.49
HUMIDITY CORRECTION FACTOR = .87
GRAINS OF WATER/LB DRY AIR = 43.76

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)		AIR FUEL RATIO		B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	7.29	2.50	29.00	791.3	32.7(	.0)	7.2(	.0)	22.82	2.48	7.63	7.22	1069.18	10.11
40.0	7.29	2.50	29.00	782.1	32.0(	.0)	7.1(	.0)	23.08	2.95	3.11	6.97	1055.65	6.05
40.0	7.29	2.50	29.00	773.9	31.8(	.0)	7.1(	.0)	23.33	3.79	1.72	6.64	1042.52	5.52
40.0	7.29	2.50	29.00	780.6	31.9(	.0)	7.1(	.0)	23.13	4.85	1.14	7.18	1048.00	5.99
40.0	7.29	2.50	29.00	787.4	32.2(	.0)	7.1(	.0)	22.93	5.67	.83	7.48	1054.70	6.50
40.0	7.29	2.50	29.00	792.1	32.3(	.0)	7.1(	.0)	22.79	6.25	.59	8.10	1058.47	6.84
40.0	7.29	2.50	29.00	797.6	32.4(	.0)	7.1(	.0)	22.64	7.71	.35	9.40	1059.94	8.06

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 83-86

E.G.R. LOOP AT 40 REV/SEC 2.5 BAR BMEP 0.8 E.R.

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
2	2	86	57.00	758.50	12.00	20.00	0	0.	4

1 ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00
28 IGNITION TIMING	15.00	17.00	20.00	24.00
4 FUEL VOLUME (CC)	102.50	102.50	102.50	102.50
2 BRAKE LOAD	29.00	29.00	29.00	29.00
5 FUEL TIME (SEC)	52.75	53.30	53.00	52.25
6 FUEL TEMPERATURE (C)	11.00	11.00	11.00	11.00
8 AIR METER TEMPERATURE (C)	17.00	17.00	17.00	17.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-356.45	-325.62	-286.51	-240.64
26 EXHAUST TEMP. (POST TURBO)	385.0	385.0	382.0	376.0
27 EXHAUST PRESSURE (POST TURBO)	12.0	11.3	11.3	11.3
13 CARBON MONOXIDE (%)	.125	.122	.134	.172
15 CARBON DIOXIDE (%)	11.500	11.500	11.500	11.500
16 OXYGEN (%)	4.700	4.700	4.700	4.800
12 HYDROCARBONS (PPMC)	1260.0	1620.0	1980.0	2820.0
14 OXIDES OF NITROGEN (PPM)	-410.0	-160.0	-85.0	-52.0
17 INTAKE MANIFOLD CO2 (%)	.020	.800	1.510	2.060
30 AMBIENT CO2 (%)	.020	.020	.020	.020

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 83-86

E.G.R. LOOP AT 40 REV/SEC 2.5 BAR BMEP 0.8 E.R.

DATE 2/ 2/86 TEST NO. 57.0 BAROMETER 758.50 MM.HG WET BULB TEMP(C) 12.0
DRY BULB TEMP(C) 20.0

RELATIVE HUMIDITY = 36.93
HUMIDITY CORRECTION FACTOR = .84
GRAINS OF WATER/LB DRY AIR = 37.46

:::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
:::

RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	7.29	2.50	29.00	765.8	35.3(.0)	8.1(.0)	23.58	4.11	3.96	7.12	1029.81	8.07
40.0	7.29	2.50	29.00	757.9	34.8(.0)	8.0(.0)	23.82	5.21	1.53	6.86	1016.35	6.73
40.0	7.29	2.50	29.00	762.2	34.9(.0)	8.0(.0)	23.69	6.38	.81	7.55	1017.93	7.19
40.0	7.29	2.50	29.00	773.1	35.2(.0)	8.0(.0)	23.35	9.12	.50	9.73	1022.01	9.62

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 83-86

E.G.R. LOOP AT 40 REV/SEC 2.5 BAR BMEP 0.7 E.R.

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
2	2	86	58.00	758.50	12.00	20.00	0	0.	4

1 ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00
28 IGNITION TIMING	21.00	24.00	28.00	31.00
4 FUEL VOLUME (CC)	102.50	102.50	102.50	102.50
2 BRAKE LOAD	29.00	29.00	29.00	29.00
5 FUEL TIME (SEC)	53.30	53.35	52.40	51.50
6 FUEL TEMPERATURE (C)	11.00	11.00	11.00	11.00
8 AIR METER TEMPERATURE (C)	17.00	17.00	18.00	18.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-326.37	-291.02	-251.92	-210.56
26 EXHAUST TEMP. (POST TURBO)	379.0	376.0	369.0	363.0
27 EXHAUST PRESSURE (POST TURBO)	12.8	12.8	12.8	12.0
13 CARBON MONOXIDE (%)	.122	.152	.188	.208
15 CARBON DIOXIDE (%)	9.900	9.900	9.900	9.900
16 OXYGEN (%)	7.000	7.000	7.000	7.000
12 HYDROCARBONS (PPMC)	1830.0	2460.0	3060.0	3750.0
14 OXIDES OF NITROGEN (PPM)	-160.0	-60.0	-40.0	-33.0
17 INTAKE MANIFOLD CO2 (%)	.020	.640	1.170	1.610
30 AMBIENT CO2 (%)	.020	.020	.020	.020

EPA/VW HRCC METHANOL (79.5mm x 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 83-86

E.G.P. LOOP AT 40 REV/SEC 2.5 BAR BMEP 0.7 F.R.

DATE 2/ 2/86 TEST NO. 58.0 BAROMETER 758.50 MM.HG WET BULB TEMP(C) 12.0
DRY BULB TEMP(C) 20.0

RELATIVE HUMIDITY = 36.93
HUMIDITY CORRECTION FACTOR = .84
GRAINS OF WATER/LB DRY AIR = 37.46

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::

RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	7.29	2.50	29.00	757.9	40.0(.0)	9.2(.0)	23.82	6.80	1.72	7.92	1010.30	8.51
40.0	7.29	2.50	29.00	757.2	39.7(.0)	9.2(.0)	23.84	9.04	.64	9.77	1000.24	9.68
40.0	7.29	2.50	29.00	770.9	40.2(.0)	9.1(.0)	23.42	11.35	.43	12.19	1008.96	11.78
40.0	7.29	2.50	29.00	784.4	40.6(.0)	9.0(.0)	23.02	14.03	.36	13.61	1017.86	14.39

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 79-82

E.G.R. LOOP AT 40 REV/SEC 1.5 BAR BMEP 1.0 E.R.

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
2	2	86	59.00	758.50	12.00	20.00	0	0.	4

1 ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00	40.00	40.00	40.00
28 IGNITION TIMING	13.00	15.00	18.00	22.00	26.00	32.00	34.00
4 FUEL VOLUME (CC)	52.00	52.00	52.00	52.00	52.00	52.00	52.00
2 BRAKE LOAD	17.40	17.40	17.40	17.40	17.40	17.40	17.40
5 FUEL TIME (SEC)	32.25	32.50	32.75	32.70	32.45	31.85	31.25
6 FUEL TEMPERATURE (C)	11.00	11.00	11.00	11.00	11.00	12.00	12.00
8 AIR METER TEMPERATURE (C)	19.00	19.00	19.00	18.00	19.00	18.00	19.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-461.73	-442.18	-411.34	-383.52	-362.46	-328.62	-306.82
26 EXHAUST TEMP. (POST TURBO)	368.0	365.0	362.0	358.0	356.0	351.0	352.0
27 EXHAUST PRESSURE (POST TURBO)	7.5	6.8	6.8	6.8	6.8	6.0	6.8
13 CARBON MONOXIDE (%)	.600	.600	.600	.700	.750	.800	.900
15 CARBON DIOXIDE (%)	14.300	14.300	14.400	14.400	14.300	14.100	14.100
16 OXYGEN (%)	.700	.700	.700	.800	.800	.900	.950
12 HYDROCARBONS (PPMC)	660.0	840.0	1110.0	1320.0	1620.0	2220.0	2340.0
14 OXIDES OF NITROGEN (PPM)	-440.0	-210.0	-110.0	-65.0	-40.0	-28.0	-22.0
17 INTAKE MANIFOLD CO2 (%)	.030	.960	1.740	2.380	3.080	3.750	4.180
30 AMBIENT CO2 (%)	.030	.030	.030	.030	.030	.030	.030

EPA/VW HPCC METHANOL (79.5mm x 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 79-82

E.G.R. LOOP AT 40 REV/SEC 1.5 BAR BMEP 1.0 E.R.

DATE 2/ 2/86 TEST NO. 59 BAROMETER 758.50 MM.HG WET BULB TEMP(C) 12.0
DRY BULB TEMP(C) 20.0

RELATIVE HUMIDITY = 36.93
HUMIDITY CORRECTION FACTOR = .84
GRAINS OF WATER/LB DRY AIR = 37.46

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	4.37	1.50	17.40	1059.1	23.7(.0)	6.5(.0)	17.05	2.34	4.85	37.13	1390.54	7.18
40.0	4.37	1.50	17.40	1051.0	23.5(.0)	6.5(.0)	17.18	2.95	2.29	36.60	1378.19	5.24
40.0	4.37	1.50	17.40	1042.9	23.3(.0)	6.5(.0)	17.31	3.83	1.18	36.22	1365.66	5.01
40.0	4.37	1.50	17.40	1044.5	23.2(.0)	6.5(.0)	17.28	4.53	.70	41.98	1355.88	5.22
40.0	4.37	1.50	17.40	1052.6	23.4(.0)	6.4(.0)	17.15	5.60	.43	45.38	1359.62	6.04
40.0	4.37	1.50	17.40	1071.4	23.7(.0)	6.4(.0)	16.85	7.86	.31	49.57	1372.74	8.17
40.0	4.37	1.50	17.40	1092.0	24.2(.0)	6.4(.0)	16.55	8.39	.25	56.42	1388.81	8.63

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 79-82

E.G.R. LOOP AT 40 REV/SEC 1.5 BAR BMEP 0.9 E.R.

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
3	2	86	60.00	758.99	10.50	18.00	0	0.	4

1 ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00	40.00	40.00
28 IGNITION TIMING	14.00	16.00	19.00	22.00	26.00	32.00
4 FUEL VOLUME (CC)	52.00	52.00	52.00	52.00	52.00	52.00
2 BRAKE LOAD	17.40	17.40	17.40	17.40	17.40	17.40
5 FUEL TIME (SEC)	33.25	33.65	33.85	33.25	32.65	31.75
6 FUEL TEMPERATURE (C)	11.00	11.00	11.00	11.00	11.00	11.00
8 AIR METER TEMPERATURE (C)	17.00	17.00	17.00	18.00	18.00	18.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-448.19	-429.39	-404.58	-370.74	-343.66	-310.58
26 EXHAUST TEMP. (POST TURBO)	368.0	365.0	361.0	357.0	355.0	350.0
27 EXHAUST PRESSURE (POST TURBO)	7.5	7.5	6.8	6.8	6.8	6.8
13 CARBON MONOXIDE (%)	.166	.160	.145	.162	.185	.220
15 CARBON DIOXIDE (%)	13.200	13.300	13.200	13.200	13.200	13.200
16 OXYGEN (%)	2.500	2.500	2.500	2.500	2.500	2.500
12 HYDROCARBONS (PPMC)	840.0	1020.0	1320.0	1830.0	2460.0	3000.0
14 OXIDES OF NITROGEN (PPM)	-480.0	-245.0	-125.0	-55.0	-36.0	-30.0
17 INTAKE MANIFOLD CO2 (%)	.020	.880	1.540	2.290	2.890	3.480
30 AMBIENT CO2 (%)	.020	.020	.020	.020	.020	.020

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 79-82

E.G.R. LOOP AT 40 REV/SEC 1.5 BAR BMEP 0.9 E.R.

DATE 3/ 2/86 TEST NO. 60.0 BAROMETER 756.99 MM.HG WET BULB TEMP(C) 10.5
DRY BULB TEMP(C) 18.0

RELATIVE HUMIDITY = 37.02
HUMIDITY CORRECTION FACTOR = .82
GRAINS OF WATER/LB DRY AIR = 33.09

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)		AIR FUEL RATIO		B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	4.37	1.50	17.40	1027.2	25.2(	.0)	7.2(	.0)	17.58	3.21	5.44	11.09	1385.30	8.65
40.0	4.37	1.50	17.40	1015.0	24.9(	.0)	7.1(	.0)	17.79	3.82	2.72	10.47	1367.81	6.54
40.0	4.37	1.50	17.40	1009.0	24.7(	.0)	7.1(	.0)	17.89	4.94	1.39	9.49	1358.02	6.33
40.0	4.37	1.50	17.40	1027.2	25.1(	.0)	7.1(	.0)	17.58	6.94	.62	10.74	1375.56	7.56
40.0	4.37	1.50	17.40	1046.1	25.4(	.0)	7.1(	.0)	17.26	9.44	.41	12.42	1392.02	9.85
40.0	4.37	1.50	17.40	1075.8	26.0(	.0)	7.0(	.0)	16.78	11.76	.35	15.09	1422.20	12.11

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 79-82

E.G.R. LOOP AT 40 REV/SEC 1.5 BAR BMEP 0.8 E.R.

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
3	2	86	61.00	758.39	10.00	18.00	0	0.	4

1	ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00
28	IGNITION TIMING	15.00	18.00	22.00	27.00
4	FUEL VOLUME (CC)	52.00	52.00	52.00	52.00
2	BRAKE LOAD	17.40	17.40	17.40	17.40
5	FUEL TIME (SEC)	33.65	33.90	33.85	33.25
6	FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00
8	AIR METER TEMPERATURE (C)	17.00	17.00	17.00	17.00
11	INTAKE MANIFOLD PRESS.(mm.Hg)	-427.14	-412.85	-386.53	-350.43
26	EXHAUST TEMP. (POST TURBO)	366.0	359.0	356.0	351.0
27	EXHAUST PRESSURE (POST TURBO)	8.3	8.3	7.5	7.5
13	CARBON MONOXIDE (%)	.133	.133	.142	.167
15	CARBON DIOXIDE (%)	11.400	11.500	11.500	11.500
16	OXYGEN (%)	4.800	4.700	4.700	4.700
12	HYDROCARBONS (PPMC)	1260.0	1470.0	1740.0	2250.0
14	OXIDES OF NITROGEN (PPM)	-195.0	-90.0	-55.0	-42.0
17	INTAKE MANIFOLD CO2 (%)	.020	.740	1.230	1.900
30	AMBIENT CO2 (%)	.020	.020	.020	.020

EPA/VW HRCC METHANOL (79.5mm x 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 79-82

E.G.R. LOOP AT 40 REV/SEC 1.5 BAR BMEP 0.8 E.R.

DATE 3/ 2/86 TEST NO. 61.0 BAROMETER 758.39 MM.HG WET BULB TEMP(C) 10.0
DRY BULB TEMP(C) 18.0

RELATIVE HUMIDITY = 33.38
HUMIDITY CORRECTION FACTOR = .80
GRAINS OF WATER/LB DRY AIR = 29.84

:::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
:::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	4.37	1.50	17.40	1014.1	28.2(.0)	8.1(.0)	17.80	5.48	2.39	10.12	1362.55	7.87
40.0	4.37	1.50	17.40	1006.6	27.8(.0)	8.0(.0)	17.94	6.28	1.09	9.94	1350.35	7.37
40.0	4.37	1.50	17.40	1008.1	27.7(.0)	8.0(.0)	17.91	7.42	.66	10.60	1348.21	8.09
40.0	4.37	1.50	17.40	1026.3	28.1(.0)	8.0(.0)	17.59	9.71	.51	12.60	1363.77	10.22

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

E.G.R. LOOP AT 40 REV/SEC 1.5 BAR BMEP 0.7 E.R.

REFER TO FIGURE NOS. 79-82

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
3	2	86	62.00	758.39	10.00	18.00	0	0.	4

1	ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00
28	IGNITION TIMING	22.00	26.00	31.00	36.00
4	FUEL VOLUME (CC)	52.00	52.00	52.00	52.00
2	BRAKE LOAD	17.40	17.40	17.40	17.40
5	FUEL TIME (SEC)	34.15	34.05	33.65	32.95
6	FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00
8	AIR METER TEMPERATURE (C)	17.00	17.00	17.00	17.00
11	INTAKE MANIFOLD PRESS.(mm.Hg)	-400.82	-379.01	-354.94	-330.88
26	EXHAUST TEMP. (POST TURBO)	355.0	351.0	346.0	337.0
27	EXHAUST PRESSURE (POST TURBO)	9.0	9.0	8.3	8.3
13	CARBON MONOXIDE (%)	.134	.160	.192	.215
15	CARBON DIOXIDE (%)	9.900	9.900	9.900	9.800
16	OXYGEN (%)	7.000	6.900	7.000	7.100
12	HYDROCARBONS (PPMC)	1830.0	2220.0	3150.0	3900.0
14	OXIDES OF NITROGEN (PPM)	-80.0	-50.0	-32.0	-28.0
17	INTAKE MANIFOLD CO2 (%)	.020	.670	1.200	1.560
30	AMBIENT CO2 (%)	.020	.020	.020	.020

EPA/VW UREC METHANOL (79.5mm x 73.4mm)

M.F.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 79-82

E.G.R. LOOP AT 40 REV/SEC 1.5 BAR BMEP 0.7 E.R.

DATE 3/ 2/86 TEST NO. 62.0 BAROMETER 758.39 MM.HG WET BULB TEMP(C) 10.0
DRY BULB TEMP(C) 18.0

RELATIVE HUMIDITY = 33.38
HUMIDITY CORRECTION FACTOR = .80
GRAINS OF WATER/LB DRY AIR = 29.84

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::

RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	4.37	1.50	17.40	999.3	31.7(.0)	9.2(.0)	18.07	8.95	1.08	11.46	1330.49	10.03
40.0	4.37	1.50	17.40	1002.2	31.4(.0)	9.1(.0)	18.01	10.82	.67	13.64	1325.96	11.49
40.0	4.37	1.50	17.40	1014.1	31.6(.0)	9.1(.0)	17.80	15.35	.43	16.36	1325.60	15.78
40.0	4.37	1.50	17.40	1035.7	32.2(.0)	9.1(.0)	17.45	19.41	.38	18.72	1340.35	19.79

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 91-94

E.G.R. LOOP AT 60 REV/SEC 2.5 BAR BMEP 1.0 E.R.

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
4	2	86	63.00	763.64	13.00	21.50	0	0.	4

1 ENGINE SPEED (REV/S)	60.00	60.00	60.00	60.00
28 IGNITION TIMING	17.00	19.00	21.00	24.00
4 FUEL VOLUME (CC)	203.00	203.00	203.00	203.00
2 BRAKE LOAD	29.00	29.00	29.00	29.00
5 FUEL TIME (SEC)	62.75	62.95	62.85	62.50
6 FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00
8 AIR METER TEMPERATURE (C)	15.00	16.00	16.00	17.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-405.33	-386.53	-349.66	-307.57
26 EXHAUST TEMP. (POST TURBO)	491.0	486.0	483.0	475.0
27 EXHAUST PRESSURE (POST TURBO)	21.8	21.8	21.1	21.1
13 CARBON MONOXIDE (%)	.500	.500	.500	.500
15 CARBON DIOXIDE (%)	14.600	14.600	14.500	14.500
16 OXYGEN (%)	.500	.500	.500	.500
12 HYDROCARBONS (PPMC)	570.0	630.0	870.0	1080.0
14 OXIDES OF NITROGEN (PPM)	-1200.0	-710.0	-370.0	-185.0
17 INTAKE MANIFOLD CO2 (%)	.030	.660	1.390	2.160
30 AMBIENT CO2 (%)	.030	.030	.030	.030

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 91-94

E.G.R. LOOP AT 60 REV/SEC 2.5 BAR BMEP 1.0 E.R.

DATE 4/ 2/86 TEST NO. 63.0 BAROMETER 763.64 MM.HG WET BULB TEMP(C) 13.0
DRY BULB TEMP(C) 21.5

RELATIVE HUMIDITY = 35.92
HUMIDITY CORRECTION FACTOR = .85
GRAINS OF WATER/LB DRY AIR = 39.70

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
60.0	10.93	2.50	29.00	849.2	30.9(.0)	6.5(.0)	21.26	1.60	10.65	24.50	1124.00	12.24
60.0	10.93	2.50	29.00	846.5	30.9(.0)	6.4(.0)	21.33	1.76	6.28	24.41	1119.99	8.03
60.0	10.93	2.50	29.00	847.8	30.9(.0)	6.4(.0)	21.29	2.44	3.29	24.57	1119.70	5.73
60.0	10.93	2.50	29.00	852.6	31.1(.0)	6.4(.0)	21.18	3.05	1.65	24.68	1124.40	4.70

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 91-94

E.G.R. LOOP AT 60 REV/SEC 2.5 BAR BMEP 0.9 E.R.

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
4	2	86	64.00	763.64	13.00	21.50	0	0.	4

1	ENGINE SPEED (REV/S)	60.00	60.00	60.00	60.00
28	IGNITION TIMING	19.00	20.00	22.00	24.00
4	FUEL VOLUME (CC)	203.00	203.00	203.00	203.00
2	BRAKE LOAD	29.00	29.00	29.00	29.00
5	FUEL TIME (SEC)	64.15	65.25	65.25	64.65
6	FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00
8	AIR METER TEMPERATURE (C)	15.00	16.00	17.00	17.00
11	INTAKE MANIFOLD PRESS.(mm.Hg)	-387.28	-369.23	-334.64	-290.27
26	EXHAUST TEMP. (POST TURBO)	479.0	480.0	475.0	468.0
27	EXHAUST PRESSURE (POST TURBO)	22.6	22.6	22.6	21.8
13	CARBON MONOXIDE (%)	.155	.164	.150	.138
15	CARBON DIOXIDE (%)	13.200	13.200	13.200	13.200
16	OXYGEN (%)	2.500	2.500	2.500	2.500
12	HYDROCARBONS (PPMC)	570.0	720.0	960.0	1350.0
14	OXIDES OF NITROGEN (PPM)	-1150.0	-620.0	-340.0	-160.0
17	INTAKE MANIFOLD CO2 (%)	.030	.600	1.190	1.890
30	AMBIENT CO2 (%)	.030	.030	.030	.030

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

E.G.R. LOOP AT 60 REV/SEC 2.5 BAR BMEP 0.9 E.R.

REFER TO FIGURE NOS. 91-94

DATE 4/ 2/86 TEST NO. 64.0 BAROMETER 763.64 MM.HG WET BULB TEMP(C) 13.0
DRY BULB TEMP(C) 21.5

RELATIVE HUMIDITY = 35.92
HUMIDITY CORRECTION FACTOR = .85
GRAINS OF WATER/LB DRY AIR = 39.70

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)		AIR FUEL RATIO		B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
60.0	10.93	2.50	29.00	830.7	33.7(	.0)	7.2(	.0)	21.73	1.77	10.99	8.40	1123.37	12.76
60.0	10.93	2.50	29.00	816.7	33.1(	.0)	7.2(	.0)	22.11	2.19	5.82	8.72	1102.46	8.01
60.0	10.93	2.50	29.00	816.7	33.2(	.0)	7.2(	.0)	22.11	2.92	3.19	7.97	1101.64	6.10
60.0	10.93	2.50	29.00	824.2	33.4(	.0)	7.1(	.0)	21.90	4.13	1.51	7.38	1109.64	5.64

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 91-94

E.G.R. LOOP AT 60 REV/SEC 2.5 BAR BMEP 0.8 E.R.

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
4	2	86	65.00	763.64	13.00	21.50	0	0.	4

1	ENGINE SPEED (REV/S)	60.00	60.00	60.00	60.00
28	IGNITION TIMING	20.00	22.00	24.00	26.00
4	FUEL VOLUME (CC)	203.00	203.00	203.00	203.00
2	BRAKE LOAD	29.00	29.00	29.00	29.00
5	FUEL TIME (SEC)	66.50	66.65	66.75	66.10
6	FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00
8	AIR METER TEMPERATURE (C)	16.00	17.00	17.00	16.00
11	INTAKE MANIFOLD PRESS.(mm.Hg)	-363.22	-334.64	-296.29	-255.68
26	EXHAUST TEMP. (POST TURBO)	469.0	463.0	461.0	450.0
27	EXHAUST PRESSURE (POST TURBO)	24.8	24.8	24.1	24.1
13	CARBON MONOXIDE (%)	.140	.126	.128	.145
15	CARBON DIOXIDE (%)	11.500	11.500	11.500	11.500
16	OXYGEN (%)	4.700	4.700	4.700	4.700
12	HYDROCARBONS (PPMC)	960.0	1350.0	1530.0	1860.0
14	OXIDES OF NITROGEN (PPM)	-560.0	-225.0	-145.0	-90.0
17	INTAKE MANIFOLD CO2 (%)	.030	.600	1.150	1.680
30	AMBIENT CO2 (%)	.030	.030	.030	.030

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 91-94

E.G.R. LOOP AT 60 REV/SEC 2.5 BAR BMEP 0.8 E.R.

DATE 4/ 2/86 TEST NO. 65.0 BAROMETER 763.64 MM.HG WET BULB TEMP(C) 13.0
DRY BULB TEMP(C) 21.5

RELATIVE HUMIDITY = 35.92
HUMIDITY CORRECTION FACTOR = .85
GRAINS OF WATER/LB DRY AIR = 39.70

:::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
:::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)		AIR FUEL RATIO		B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
60.0	10.93	2.50	29.00	801.3	36.6(	.0)	8.1(	.0)	22.53	3.28	5.74	8.36	1078.94	9.02
60.0	10.93	2.50	29.00	799.5	36.6(	.0)	8.1(	.0)	22.58	4.59	2.30	7.49	1074.22	6.89
60.0	10.93	2.50	29.00	798.3	36.4(	.0)	8.0(	.0)	22.62	5.18	1.48	7.59	1070.79	6.66
60.0	10.93	2.50	29.00	806.2	36.5(	.0)	8.0(	.0)	22.40	6.34	.92	8.64	1076.75	7.26

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 91-94

E.G.R. LOOP AT 60 REV/SEC 2.5 BAR BMEP 0.7 E.R.

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
4	2	86	66.00	763.64	13.00	21.50	0	0.	4

1	ENGINE SPEED (REV/S)	60.00	60.00	60.00	60.00
28	IGNITION TIMING	24.00	28.00	32.00	36.00
4	FUEL VOLUME (CC)	203.00	203.00	203.00	203.00
2	BRAKE LOAD	29.00	29.00	29.00	29.00
5	FUEL TIME (SEC)	67.05	67.55	67.40	66.55
6	FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00
8	AIR METER TEMPERATURE (C)	16.00	17.00	17.00	16.00
11	INTAKE MANIFOLD PRESS.(mm.Hg)	-325.62	-293.28	-253.42	-229.36
26	EXHAUST TEMP. (POST TURBO)	456.0	448.0	439.0	433.0
27	EXHAUST PRESSURE (POST TURBO)	28.6	27.8	27.8	27.1
13	CARBON MONOXIDE (%)	.121	.138	.175	.192
15	CARBON DIOXIDE (%)	9.900	9.900	9.800	9.800
16	OXYGEN (%)	7.000	7.000	7.100	7.100
12	HYDROCARBONS (PPMC)	1500.0	1920.0	2640.0	2940.0
14	OXIDES OF NITROGEN (PPM)	-140.0	-80.0	-58.0	-54.0
17	INTAKE MANIFOLD CO2 (%)	.030	.570	.970	1.350
30	AMBIENT CO2 (%)	.030	.030	.030	.030

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

N.F.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 91-94

E.G.R. LOOP AT 60 REV/SEC 2.5 BAR BMEP 0.7 F.R.

DATE 4/ 2/86 TEST NO. 66.0 BAROMETER 763.64 MM.HG WET BULB TEMP(C) 13.0
DRY BULB TEMP(C) 21.5

RELATIVE HUMIDITY = 35.92
HUMIDITY CORRECTION FACTOR = .85
GRAINS OF WATER/LB DRY AIR = 39.70

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::

RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
60.0	10.93	2.50	29.00	794.7	41.7(.0)	9.3(.0)	22.72	5.86	1.60	8.27	1062.95	7.46
60.0	10.93	2.50	29.00	788.9	41.3(.0)	9.2(.0)	22.89	7.40	.90	9.31	1049.00	8.31
60.0	10.93	2.50	29.00	790.6	41.3(.0)	9.2(.0)	22.84	10.19	.65	11.82	1039.80	10.85
60.0	10.93	2.50	29.00	800.7	41.5(.0)	9.2(.0)	22.55	11.44	.61	13.07	1048.27	12.06

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 95-98

E.G.R. LOOP AT 60 REV/SEC 5.5 BAR BMEP 1.0 E.R.

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
5	2	86	67.00	760.71	12.00	23.50	0	0.	4

1 ENGINE SPEED (REV/S)	60.00	60.00	60.00	60.00	60.00
28 IGNITION TIMING	16.00	16.00	17.00	18.00	19.00
4 FUEL VOLUME (CC)	203.00	203.00	203.00	203.00	203.00
2 BRAKE LOAD	63.80	63.80	63.80	63.80	63.80
5 FUEL TIME (SEC)	39.95	40.10	40.45	40.45	40.35
6 FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00	12.00
8 AIR METER TEMPERATURE (C)	16.00	16.00	16.00	16.00	16.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-222.59	-211.31	-185.74	-154.16	-126.34
26 EXHAUST TEMP. (POST TURBO)	577.0	570.0	566.0	561.0	556.0
27 EXHAUST PRESSURE (POST TURBO)	48.9	46.6	46.6	45.1	44.4
13 CARBON MONOXIDE (%)	.500	.500	.500	.500	.500
15 CARBON DIOXIDE (%)	14.500	14.600	14.600	14.600	14.600
16 OXYGEN (%)	.500	.500	.500	.500	.500
12 HYDROCARBONS (PPMC)	720.0	750.0	840.0	960.0	1020.0
14 OXIDES OF NITROGEN (PPM)	-2000.0	-1400.0	-1050.0	-720.0	-600.0
17 INTAKE MANIFOLD CO2 (%)	.040	.430	.830	1.200	1.490
30 AMBIENT CO2 (%)	.040	.040	.040	.040	.040

EPA/VW HRCC METHANOL (79.5mm x 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 95-98

E.G.R. LOOP AT 60 REV/SEC 5.5 BAR BMEP 1.0 E.R.

DATE 5/ 2/86 TEST NO. 67.0 BAROMETER 760.71 MM.HG WET BULB TEMP(C) 12.0
DRY BULB TEMP(C) 23.5

RELATIVE HUMIDITY = 21.60
HUMIDITY CORRECTION FACTOR = .78
GRAINS OF WATER/LB DRY AIR = 26.98

: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :

RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
60.0	24.05	5.50	63.80	606.3	48.9(.0)	6.5(.0)	29.78	1.45	11.74	17.59	801.49	13.19
60.0	24.05	5.50	63.80	604.0	48.7(.0)	6.4(.0)	29.89	1.49	8.15	17.41	798.54	9.64
60.0	24.05	5.50	63.80	598.8	48.2(.0)	6.4(.0)	30.15	1.66	6.05	17.24	791.16	7.71
60.0	24.05	5.50	63.80	598.8	48.1(.0)	6.4(.0)	30.15	1.89	4.15	17.23	790.54	6.04
60.0	24.05	5.50	63.80	600.3	48.2(.0)	6.4(.0)	30.08	2.01	3.46	17.27	792.19	5.48

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

E.G.R. LOOP AT 60 REV/SEC 5.5 BAR BMEP 0.9 E.R.

REFER TO FIGURE NOS. 95-98

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
5	2	86	68.00	760.71	12.00	23.50	0	0.	4

1 ENGINE SPEED (REV/S)	60.00	60.00	60.00	60.00	60.00
28 IGNITION TIMING	18.00	18.00	19.00	20.00	20.00
4 FUEL VOLUME (CC)	203.00	203.00	203.00	203.00	203.00
2 BRAKE LOAD	63.80	63.80	63.80	63.80	63.80
5 FUEL TIME (SEC)	41.45	41.40	41.55	41.45	41.10
6 FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00	12.00
8 AIR METER TEMPERATURE (C)	14.00	15.00	16.00	16.00	16.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-206.05	-182.74	-151.90	-124.83	-97.76
26 EXHAUST TEMP. (POST TURBO)	553.0	553.0	551.0	548.0	545.0
27 EXHAUST PRESSURE (POST TURBO)	48.1	48.1	48.1	47.4	47.4
13 CARBON MONOXIDE (%)	.126	.140	.150	.150	.150
15 CARBON DIOXIDE (%)	13.200	13.200	13.100	13.100	13.100
16 OXYGEN (%)	2.500	2.500	2.500	2.500	2.500
12 HYDROCARBONS (PPMC)	570.0	630.0	660.0	750.0	810.0
14 OXIDES OF NITROGEN (PPM)	-1850.0	-1350.0	-1000.0	-860.0	-750.0
17 INTAKE MANIFOLD CO2 (%)	.020	.460	.760	1.020	1.210
30 AMBIENT CO2 (%)	.020	.020	.020	.020	.020

EPA/VW HRCC METHANOL (79.5mm x 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 95-98

E.G.R. LOOP AT 60 REV/SEC 5.5 BAR BMEP 0.9 E.R.

DATE 5/ 2/86 TEST NO. 68.0 BAROMETER 760.71 MM.HG WET BULB TEMP(C) 12.0
DRY BULB TEMP(C) 23.5

RELATIVE HUMIDITY = 21.60
HUMIDITY CORRECTION FACTOR = .78
GRAINS OF WATER/LB DRY AIR = 26.98

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
60.0	24.05	5.50	63.80	584.4	52.2(.0)	7.2(.0)	30.90	1.24	11.51	4.81	791.98	12.75
60.0	24.05	5.50	63.80	585.1	52.4(.0)	7.2(.0)	30.86	1.37	8.40	5.34	791.75	9.77
60.0	24.05	5.50	63.80	582.9	52.4(.0)	7.2(.0)	30.97	1.44	6.23	5.74	788.03	7.67
60.0	24.05	5.50	63.80	584.4	52.4(.0)	7.2(.0)	30.90	1.64	5.37	5.75	789.40	7.01
60.0	24.05	5.50	63.80	589.3	52.9(.0)	7.2(.0)	30.63	1.79	4.72	5.86	795.77	6.51

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 95-98

E.G.R. LOOP AT 60 REV/SEC 5.5 BAR BMEP 0.8 F.R.

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
5	2	86	69.00	760.71	12.00	23.50	0	0.	4

1 ENGINE SPEED (REV/S)	60.00	60.00	60.00	60.00
28 IGNITION TIMING	19.00	19.00	20.00	21.00
4 FUEL VOLUME (CC)	203.00	203.00	203.00	203.00
2 BRAKE LOAD	63.80	63.80	63.80	63.80
5 FUEL TIME (SEC)	42.35	42.55	42.50	42.40
6 FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00
8 AIR METER TEMPERATURE (C)	15.00	16.00	16.00	16.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-169.95	-141.30	-106.78	-79.71
26 EXHAUST TEMP. (POST TURBO)	532.0	532.0	526.0	517.0
27 EXHAUST PRESSURE (POST TURBO)	53.4	52.6	52.6	51.9
13 CARBON MONOXIDE (%)	.130	.134	.128	.126
15 CARBON DIOXIDE (%)	11.600	11.600	11.600	11.500
16 OXYGEN (%)	4.700	4.700	4.700	4.700
12 HYDROCARBONS (PPMC)	750.0	840.0	930.0	1080.0
14 OXIDES OF NITROGEN (PPM)	-1000.0	-600.0	-440.0	-290.0
17 INTAKE MANIFOLD CO2 (%)	.030	.440	.680	.880
30 AMBIENT CO2 (%)	.030	.030	.030	.030

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 95-98

E.G.R. LOOP AT 60 REV/SEC 5.5 BAR BMEP 0.8 E.R.

DATE 5/ 2/86 TEST NO. 69.0 BAROMETER 760.71 MM.HG WET BULB TEMP(C) 12.0
DRY BULB TEMP(C) 23.5

RELATIVE HUMIDITY = 21.60
HUMIDITY CORRECTION FACTOR = .78
GRAINS OF WATER/LB DRY AIR = 26.98

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
60.0	24.05	5.50	63.80	571.9	57.6(.0)	8.1(.0)	31.57	1.82	6.73	5.51	772.25	8.54
60.0	24.05	5.50	63.80	569.2	57.4(.0)	8.1(.0)	31.72	2.02	4.01	5.64	767.77	6.04
60.0	24.05	5.50	63.80	569.9	57.5(.0)	8.1(.0)	31.68	2.24	2.95	5.40	768.40	5.19
60.0	24.05	5.50	63.80	571.3	57.6(.0)	8.1(.0)	31.60	2.63	1.96	5.36	769.32	4.59

EPA/VW URCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

E.G.R. LOOP AT 60 REV/SEC 5.5 BAR BMEP 0.7 E.R.

REFER TO FIGURE NOS. 95-98

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
5	2	86	69.00	760.71	12.00	23.50	0	0.	4

1	ENGINE SPEED (REV/S)	60.00	60.00
28	IGNITION TIMING	24.00	25.00
4	FUEL VOLUME (CC)	203.00	203.00
2	BRAKE LOAD	63.60	63.80
5	FUEL TIME (SEC)	42.75	42.80
6	FUEL TEMPERATURE (C)	12.00	12.00
8	AIR METER TEMPERATURE (C)	15.00	17.00
11	INTAKE MANIFOLD PRESS.(mm.Hg)	-112.80	-82.72
26	EXHAUST TEMP. (POST TURBO)	504.0	501.0
27	EXHAUST PRESSURE (POST TURBO)	61.7	60.9
13	CARBON MONOXIDE (%)	.121	.127
15	CARBON DIOXIDE (%)	9.900	9.800
16	OXYGEN (%)	7.000	7.000
12	HYDROCARBONS (PPMC)	1230.0	1380.0
14	OXIDES OF NITROGEN (PPM)	-300.0	-220.0
17	INTAKE MANIFOLD CO2 (%)	.030	.330
30	AMBIENT CO2 (%)	.030	.030

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.F.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 95-98

E.G.R. LOOP AT 60 REV/SEC 5.5 BAR BMEP 0.7 F.R.

DATE 5/ 2/86 TEST NO. 69.0 BAROMETER 760.71 MM.HG WET BULB TEMP(C) 12.0
DRY BULB TEMP(C) 23.5

RELATIVE HUMIDITY = 21.60
HUMIDITY CORRECTION FACTOR = .78
GRAINS OF WATER/LB DRY AIR = 26.98

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
60.0	24.05	5.50	63.80	566.6	65.6(.0)	9.3(.0)	31.86	3.43	2.26	5.91	759.82	5.70
60.0	24.05	5.50	63.80	565.9	66.1(.0)	9.3(.0)	31.90	3.88	1.67	6.24	757.16	5.55

EPA/VW HRCC METHANOL (79.5mm x 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 99-102

F.G.R. LOOP AT 60 REV/SEC 7.0 BAR BMEP 1.0 E.R.

DATE 6/ 2/86 TEST NO. 71.0 BAROMETER 760.71 MM.HG WET BULB TEMP(C) 14.0
DRY BULB TEMP(C) 19.5

RELATIVE HUMIDITY = 54.13
HUMIDITY CORRECTION FACTOR = .91
GRAINS OF WATER/LB DRY AIR = 53.26

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
60.0	30.61	7.00	81.20	567.7	57.9(.0)	6.5(.0)	31.80	1.24	13.05	19.64	745.79	14.29
60.0	30.61	7.00	81.20	563.2	57.2(.0)	6.5(.0)	32.06	1.34	7.89	19.48	739.61	9.23
60.0	30.61	7.00	81.20	562.6	57.4(.0)	6.4(.0)	32.09	1.51	6.97	16.31	743.54	8.48

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 99-102

E.G.R. LOOP AT 60 REV/SEC 7.0 BAR BMEP 1.0 E.R.

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
6	2	86	71.00	760.71	14.00	19.50	0	0.	4

1	ENGINE SPEED (REV/S)	60.00	60.00	60.00
28	IGNITION TIMING	16.00	16.00	17.00
4	FUEL VOLUME (CC)	304.00	304.00	304.00
2	BRAKE LOAD	81.20	81.20	81.20
5	FUEL TIME (SEC)	50.25	50.65	50.70
6	FUEL TEMPERATURE (C)	11.00	11.00	11.00
8	AIR METER TEMPERATURE (C)	14.00	13.00	15.00
11	INTAKE MANIFOLD PRESS.(mm.Hg)	-151.90	-131.60	-92.50
26	EXHAUST TEMP. (POST TURBO)	592.0	586.0	582.0
27	EXHAUST PRESSURE (POST TURBO)	63.9	60.9	60.9
13	CARBON MONOXIDE (%)	.600	.600	.500
15	CARBON DIOXIDE (%)	14.500	14.500	14.500
16	OXYGEN (%)	.600	.600	.500
12	HYDROCARBONS (PPMC)	660.0	720.0	810.0
14	OXIDES OF NITROGEN (PPM)	-2050.0	-1250.0	-1100.0
17	INTAKE MANIFOLD CO2 (%)	.020	.480	.820
30	AMBIENT CO2 (%)	.020	.020	.020

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

E.G.R. LOOP AT 60 REV/SEC 7.0 BAR BMEP 0.9 E.R.

REFER TO FIGURE NOS. 99-102

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
6	2	86	72.00	760.71	14.00	19.50	0	0.	4

1	ENGINE SPEED (REV/S)	60.00	60.00
28	IGNITION TIMING	16.00	16.00
4	FUEL VOLUME (CC)	304.00	304.00
2	BRAKE LOAD	81.20	81.20
5	FUEL TIME (SEC)	52.45	52.50
6	FUEL TEMPERATURE (C)	11.00	11.00
8	AIR METER TEMPERATURE (C)	13.00	14.00
11	INTAKE MANIFOLD PRESS.(mm.Hg)	-121.82	-91.74
26	EXHAUST TEMP. (POST TURBO)	568.0	574.0
27	EXHAUST PRESSURE (POST TURBO)	64.7	64.7
13	CARBON MONOXIDE (%)	.108	.130
15	CARBON DIOXIDE (%)	13.200	13.200
16	OXYGEN (%)	2.500	2.500
12	HYDROCARBONS (PPMC)	540.0	570.0
14	OXIDES OF NITROGEN (PPM)	-1900.0	-1400.0
17	INTAKE MANIFOLD CO2 (%)	.030	.410
30	AMBIENT CO2 (%)	.030	.030

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 99-102

E.G.R. LOOP AT 60 REV/SEC 7.0 BAR BMEP 0.9 E.R.

DATE 6/ 2/86 TEST NO. 72.0 BAROMETER 760.71 MM.HG WET BULB TEMP(C) 14.0
DRY BULB TEMP(C) 19.5

RELATIVE HUMIDITY = 54.13
HUMIDITY CORRECTION FACTOR = .91
GRAINS OF WATER/LB DRY AIR = 53.26

: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :

RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
60.0	30.61	7.00	81.20	543.9	61.7(.0)	7.2(.0)	33.20	1.10	12.82	3.84	738.27	13.92
60.0	30.61	7.00	81.20	543.3	61.7(.0)	7.2(.0)	33.25	1.16	9.42	4.61	736.19	10.58

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

REFER TO FIGURE NOS. 104-109

MAPPING AT 20 REV/SEC E.O.I. 330 ATDCF

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
13	2	.86	73.00	766.49	9.00	16.50	0	0.	1

1 ENGINE SPEED (REV/S)	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
28 IGNITION TIMING	23.00	23.00	23.00	22.00	19.50	16.00	13.00	9.50	5.00
4 FUEL VOLUME (CC)	52.00	52.00	52.00	52.00	52.00	52.00	102.50	102.50	102.50
2 BRAKE LOAD	5.50	11.70	23.40	35.50	46.60	58.50	70.80	82.50	93.40
5 FUEL TIME (SEC)	92.80	77.20	60.40	49.50	41.60	35.10	57.60	48.90	39.20
6 FUEL TEMPERATURE (C)	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
8 AIR METER TEMPERATURE (C)	15.00	14.00	13.00	13.00	13.00	14.00	14.00	14.00	15.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-472.26	-424.88	-332.38	-246.66	-165.44	-91.74	-70.69	-50.38	-.75
26 EXHAUST TEMP. (POST TURBO)	217.0	215.0	234.0	262.0	282.0	324.0	331.0	352.0	360.0
27 EXHAUST PRESSURE (POST TURBO)	3.0	3.8	3.8	5.3	9.0	12.0	13.5	14.3	15.0
13 CARBON MONOXIDE (%)	.205	.166	.135	.135	.133	.124	.104	.250	3.500
15 CARBON DIOXIDE (%)	9.600	9.800	9.800	9.800	9.800	10.200	12.500	14.500	13.300
16 OXYGEN (%)	7.100	7.200	7.200	7.100	7.100	6.600	3.900	1.100	.200
12 HYDROCARBONS (PPMC)	3600.0	2760.0	2040.0	1830.0	1620.0	1500.0	1110.0	1140.0	1500.0
14 OXIDES OF NITROGEN (PPM)	-24.0	-36.0	-75.0	-120.0	-190.0	-420.0	-1900.0	-2050.0	-460.0

EPA/VW HRCC METHANOL (79.5mm x 73.4mm)
M.E.C./BOSCH IGNITION - CORRECT INJECTORS
MAPPING AT 20 REV/SEC E.O.I. 330 ATDCF

REFER TO FIGURE NOS. 104-109

DATE 13/ 2/86 TEST NO. 73.0 BAROMETER 766.49 MM.HG WET BULB TEMP(C) 9.0 DRY BULB TEMP(C) 16.5
RELATIVE HUMIDITY = 33.95
HUMIDITY CORRECTION FACTOR = .79 GRAINS OF WATER/LB DRY AIR = 27.30

SPEED	POWER-(KW)		BMEP-(bar)		TORQUE-(NM)		FUEL-CONSUMPTION			BSFC	BOSCH	CELESCO	CORRECTED
REV/S	UN.CORR	CORR	UN.CORR	CORR	UN.CORR	CORR	G/HR	MM3/INJ	MG/LITRE	G/KW.H	SMOKE	SMOKE	AIR FLOW(SEAT)
20.00	.69	.69	.47	.47	5.50	5.50	1610.	14.01	30.67	2328.6	.0	.0	.0000
20.00	1.47	1.47	1.01	1.01	11.70	11.70	1935.	16.84	36.87	1316.0	.0	.0	.0000
20.00	2.94	2.94	2.02	2.02	23.40	23.40	2473.	21.52	47.13	841.0	.0	.0	.0000
20.00	4.46	4.46	3.06	3.06	35.50	35.50	3018.	26.26	57.51	676.4	.0	.0	.0000
20.00	5.86	5.86	4.02	4.02	46.60	46.60	3591.	31.25	68.43	613.1	.0	.0	.0000
20.00	7.35	7.35	5.04	5.04	58.50	58.50	4255.	37.04	81.10	578.9	.0	.0	.0000
20.00	8.90	8.90	6.10	6.10	70.80	70.80	5112.	44.49	97.41	574.5	.0	.0	.0000
20.00	10.37	10.37	7.11	7.11	82.50	82.50	6021.	52.40	114.74	580.6	.0	.0	.0000
20.00	11.74	11.74	8.05	8.05	93.40	93.40	7511.	65.37	143.14	639.9	.0	.0	.0000

MAN.PRES	MAN.TEMP	INTAKE-AIR-(M3/S)		AIR-MASS	FREE-AIR-VOL.EFF.		VOL.EFF.	MANIFOLD-VOL.EFF.		AIR/FUEL-RATIO		EQUIVALENCE-RATIO	
MM.HG	C	FREE	AFT.MET	KG/S	AIR-MET.	SPINDT	AFT.MET	AIR-MET.	SPINDT	AIR-MET.	SPINDT	AIR-MET.	EMISSIONS
-472.26	.0	.0000	.0000	.0000	.00	22.59	.00	.00	55.78	.00	9.10	.000	.707
-424.88	.0	.0000	.0000	.0000	.00	27.47	.00	.00	68.08	.00	9.24	.000	.697
-332.38	.0	.0000	.0000	.0000	.00	35.32	.00	.00	87.82	.00	9.33	.000	.690
-246.66	.0	.0000	.0000	.0000	.00	42.99	.00	.00	106.90	.00	9.31	.000	.692
-165.44	.0	.0000	.0000	.0000	.00	51.27	.00	.00	127.49	.00	9.33	.000	.690
-91.74	.0	.0000	.0000	.0000	.00	59.57	.00	.00	147.61	.00	9.11	.000	.707
-70.69	.0	.0000	.0000	.0000	.00	60.42	.00	.00	149.72	.00	7.69	.000	.837
-50.38	.0	.0000	.0000	.0000	.00	61.66	.00	.00	152.79	.00	6.67	.000	.966
-.75	.0	.0000	.0000	.0000	.00	65.65	.00	.00	162.62	.00	5.69	.000	1.132

HC-PPM	HC-PPM	H C	NOX-PPM	NOX-PPM	NOX-PPM	NOX	CO-PPM	CO-PPM	C O	CO2-(%)	CO2-(%)	CO2	O 2
WET	DRY	G/H	WET	DRY	DRY.COR.	G/H	WET	DRY	G/H	WET	DRY	G/H	%
3004.5	3600.0	27.95	24.0	28.8	22.6	.50	1710.9	2050.0	27.64	8.18	9.80	2091.1	7.10
2304.5	2760.0	26.07	36.0	43.1	33.9	.92	1386.0	1660.0	27.42	8.16	9.80	2543.9	7.20
1704.0	2040.0	24.88	75.0	89.8	70.6	2.47	1127.6	1350.0	28.60	8.19	9.80	3284.5	7.20
1528.6	1830.0	27.29	120.0	143.7	112.9	4.84	1127.6	1350.0	35.21	8.19	9.80	4016.0	7.10
1353.2	1620.0	28.81	190.0	227.5	178.7	9.13	1110.9	1330.0	41.37	8.19	9.80	4759.6	7.10
1244.8	1500.0	30.47	420.0	506.1	397.7	23.21	1029.0	1240.0	44.06	8.46	10.20	5694.5	6.80
887.7	1110.0	22.31	1900.0	2375.8	1866.9	107.81	831.7	1040.0	36.56	10.00	12.50	6905.0	3.90
882.2	1140.0	23.09	2050.0	2649.0	2081.6	121.13	1934.7	2500.0	88.56	11.22	14.50	8070.6	1.10
1144.2	1500.0	33.23	480.0	629.3	494.5	31.48	26698.1	35000.0	1356.33	10.15	13.30	8096.2	.20

PARTICULATES		H C	NOX	C O	CO2	START	END	START	IGNITION	EXHAUST	BRAKE	F.G.R.	BOOST PRESS.
G/H	G/KW.H	G/KW.H	G/KW.H	G/KW.H	G/KW.H	INJ.	INJ.	COMB.	TIMING	TEMP.C	THERM.EFF	(%)	RATIO
.00	.000	40.441	.729	40.281	3025.58	.0	.0	.0	23.0	217.0	7.75	.00	.384
.00	.000	17.731	.625	18.653	1730.22	.0	.0	.0	23.0	215.0	13.72	.00	.446
.00	.000	8.460	.841	9.793	1116.97	.0	.0	.0	23.0	234.0	21.47	.00	.566
.00	.000	6.117	1.084	7.893	900.24	.0	.0	.0	22.0	262.0	26.69	.00	.678
.00	.000	4.920	1.560	7.065	817.91	.0	.0	.0	19.5	282.0	29.44	.00	.784
.00	.000	4.145	3.157	5.993	774.62	.0	.0	.0	16.0	324.0	31.19	.00	.880
.00	.000	2.508	12.118	4.110	776.11	.0	.0	.0	13.0	331.0	31.42	.00	.900
.00	.000	2.227	11.684	8.543	778.49	.0	.0	.0	9.5	352.0	31.09	.00	.939
.00	.000	2.831	2.682	115.561	689.97	.0	.0	.0	5.0	360.0	28.21	.00	.999

EPA/VW PREC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

MAPPING AT 40 REV/SEC E.O.I. 330 ATDCF

REFER TO FIGURE NOS. 104-109

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
13	2	86	74.00	766.49	9.00	16.50	0	0.	1

1 ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
28 IGNITION TIMING	23.00	23.00	23.00	23.00	21.50	20.50	19.00	18.00	16.50	14.00	13.00
4 FUEL VOLUME (CC)	52.00	52.00	102.50	102.50	102.50	203.00	203.00	203.00	203.00	203.00	203.00
2 BRAKE LOAD	5.40	11.80	24.00	34.90	46.80	57.40	69.30	82.10	94.40	104.00	109.80
5 FUEL TIME (SEC)	46.30	39.90	58.60	49.10	40.90	70.20	61.40	52.70	46.10	36.10	34.00
6 FUEL TEMPERATURE (C)	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
8 AIR METER TEMPERATURE (C)	15.00	15.00	15.00	15.00	15.00	15.00	16.00	15.00	16.00	16.00	16.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-488.60	-448.19	-365.48	-297.04	-221.09	-151.90	-89.49	-75.95	-60.91	-29.33	-1.50
26 EXHAUST TEMP. (POST TURBO)	324.0	336.0	355.0	382.0	402.0	425.0	450.0	463.0	522.0	503.0	500.0
27 EXHAUST PRESSURE (POST TURBO)	5.3	6.8	10.5	14.3	18.8	24.8	30.1	32.3	36.1	40.6	43.6
13 CARBON MONOXIDE (%)	.180	.145	.125	.122	.120	.126	.120	.110	.180	4.200	5.000
15 CARBON DIOXIDE (%)	10.100	10.000	9.900	9.900	10.000	9.900	10.000	12.100	13.600	12.500	12.000
16 OXYGEN (%)	6.800	6.900	7.000	7.000	6.900	6.900	6.700	3.700	1.700	.200	.200
12 HYDROCARBONS (PPMC)	2190.0	1860.0	1740.0	1680.0	1620.0	1800.0	1590.0	1260.0	1290.0	2250.0	2040.0
14 OXIDES OF NITROGEN (PPM)	-40.0	-66.0	-120.0	-160.0	-280.0	-280.0	-600.0	-2200.0	-2600.0	-500.0	-320.0

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)
M.F.C./BOSCH IGNITION - CORRECT INJECTORS
MAPPING AT 40 REV/SEC E.O.I. 330 ATDCF

REFER TO FIGURE NOS. 104-109

DATE 13/ 2/86 TEST NO. 74.0 BAROMETER 766.49 MM.HG WET BULB TEMP(C) 9.0 DRY BULB TEMP(C) 16.5
RELATIVE HUMIDITY = 33.95
HUMIDITY CORRECTION FACTOR = .79 GRAINS OF WATER/LB DRY AIR = 27.30

SPEED	POWER-(KW)		BMEP-(bar)		TORQUE-(NM)		FUEL-CONSUMPTION			BSFC	BOSCH	CELESCU	CORRECTED
REV/S	UN.CORR.	CORR	UN.CORR	CORR	UN.CORR	CORR	G/HR	MM3/INJ	MG/LITRE	G/KW.H	SMOKE	SMOKE	AIR FLOW(SEAT)
40.00	1.36	1.36	.47	.47	5.40	5.40	3223.	14.04	30.71	2374.9	.0	.0	.0000
40.00	2.97	2.97	1.02	1.02	11.80	11.80	3740.	16.29	35.64	1261.1	.0	.0	.0000
40.00	6.03	6.03	2.07	2.07	24.00	24.00	5020.	21.86	47.83	832.2	.0	.0	.0000
40.00	8.77	8.77	3.01	3.01	34.90	34.90	5991.	26.09	57.09	683.0	.0	.0	.0000
40.00	11.76	11.76	4.03	4.03	46.80	46.80	7192.	31.33	68.53	611.5	.0	.0	.0000
40.00	14.43	14.43	4.95	4.95	57.40	57.40	8299.	36.15	79.08	575.3	.0	.0	.0000
40.00	17.42	17.42	5.97	5.97	69.30	69.30	9488.	41.33	90.41	544.8	.0	.0	.0000
40.00	20.63	20.63	7.08	7.08	82.10	82.10	11055.	48.15	105.34	535.7	.0	.0	.0000
40.00	23.73	23.73	8.14	8.14	94.40	94.40	12637.	55.04	120.42	532.6	.0	.0	.0000
40.00	26.14	26.14	8.97	8.97	104.00	104.00	16138.	70.29	153.77	617.4	.0	.0	.0000
40.00	27.60	27.60	9.47	9.47	109.80	109.80	17135.	74.63	163.27	620.9	.0	.0	.0000

MAN.PRES	MAN.TEMP	INTAKE-AIR-(M3/S)		AIR-MASS	FREE-AIR-VOL.EFF.		VOL.EFF.	MANIFOLD-VOL.EFF.		AIR/FUEL-RATIO		EQUIVALENCE-RATIO	
MM.HG	C	FREE	AFT.MET	KG/S	AIR-MET.	SPINDT	AFT.MET	AIR-MET.	SPINDT	AIR-MET.	SPINDT	AIR-MET.	EMISSIONS
-488.80	.0	.0000	.0000	.0000	.00	22.46	.00	.00	58.77	.00	9.04	.000	.712
-448.19	.0	.0000	.0000	.0000	.00	26.40	.00	.00	69.08	.00	9.16	.000	.703
-368.48	.0	.0000	.0000	.0000	.00	35.79	.00	.00	93.64	.00	9.25	.000	.696
-297.04	.0	.0000	.0000	.0000	.00	42.75	.00	.00	111.86	.00	9.26	.000	.696
-221.09	.0	.0000	.0000	.0000	.00	50.98	.00	.00	133.39	.00	9.20	.000	.700
-151.90	.0	.0000	.0000	.0000	.00	58.87	.00	.00	154.03	.00	9.20	.000	.700
-89.49	.0	.0000	.0000	.0000	.00	66.91	.00	.00	174.48	.00	9.12	.000	.706
-75.95	.0	.0000	.0000	.0000	.00	65.23	.00	.00	170.69	.00	7.66	.000	.841
-60.91	.0	.0000	.0000	.0000	.00	67.21	.00	.00	175.25	.00	6.88	.000	.936
-29.33	.0	.0000	.0000	.0000	.00	68.58	.00	.00	178.83	.00	5.49	.000	1.172
-1.50	.0	.0000	.0000	.0000	.00	70.62	.00	.00	184.15	.00	5.33	.000	1.208

HC-PPM	HC-PPM	H C	NOX-PPM	NOX-PPM	NOX-PPM	NOX	CO-PPM	CO-PPM	C O	CO2-(%)	CO2-(%)	CO2	O 2
WET	DRY	G/H	WET	DRY	DRY.COR.	G/H	WET	DRY	G/H	WET	DRY	G/H	%
1819.2	2190.0	33.61	40.0	48.2	37.8	1.67	1495.3	1800.0	48.33	8.39	10.10	4260.6	6.80
1548.3	1860.0	33.67	66.0	79.3	62.3	3.24	1207.0	1450.0	45.91	8.32	10.00	4974.6	6.90
1451.1	1740.0	42.82	120.0	143.9	113.1	7.99	1042.5	1250.0	53.80	8.26	9.90	6695.4	7.00
1401.2	1680.0	49.38	160.0	191.8	150.7	12.73	1017.5	1220.0	62.73	8.26	9.90	7997.9	7.00
1348.9	1620.0	56.66	280.0	336.3	264.2	26.55	999.2	1200.0	73.41	8.33	10.00	9611.6	6.90
1501.2	1800.0	73.18	280.0	335.7	263.8	30.82	1050.8	1260.0	89.60	8.26	9.90	11061.5	6.90
1323.9	1590.0	73.38	600.0	720.6	566.2	75.08	999.2	1200.0	96.87	8.33	10.00	12683.6	6.70
1014.1	1260.0	56.45	2200.0	2733.6	2148.0	276.52	885.3	1100.0	86.21	9.74	12.10	14899.4	3.70
1009.9	1290.0	57.77	2600.0	3321.0	2609.6	335.78	1409.2	1800.0	141.00	10.80	13.80	16984.5	1.70
1726.5	2250.0	107.26	500.0	651.6	512.0	70.13	32227.9	42000.0	3502.23	9.59	12.50	16377.4	.20
1566.5	2040.0	101.59	320.0	416.7	327.5	46.85	38394.0	50000.0	4355.05	9.21	12.00	16422.6	.20

PARTICULATES		H C	NOX	C O	CO2	START	END	START	IGNITION	EXHAUST	BRAKE	E.G.R.	BOOST PRESS.
G/H	G/KW.H	G/KW.H	G/KW.H	G/KW.H	G/KW.H	INJ.	INJ.	COMB.	TIMING	TEMP.C	THERM.EFF	(%)	RATIO
.00	.000	24.768	1.230	35.608	3139.33	.0	.0	.0	23.0	324.0	7.60	.00	.362
.00	.000	11.353	1.093	15.480	1677.41	.0	.0	.0	23.0	336.0	14.32	.00	.415
.00	.000	7.099	1.325	8.920	1110.01	.0	.0	.0	23.0	355.0	21.69	.00	.519
.00	.000	5.630	1.452	7.152	911.83	.0	.0	.0	23.0	382.0	26.43	.00	.612
.00	.000	4.817	2.257	6.241	817.17	.0	.0	.0	21.5	402.0	29.53	.00	.712
.00	.000	5.073	2.136	6.211	766.76	.0	.0	.0	20.5	425.0	31.38	.00	.602
.00	.000	4.213	4.311	5.562	728.25	.0	.0	.0	19.0	450.0	33.14	.00	.883

REFER TO FIGURE NOS. 104-109

.00	.000	2.736	13.401	4.178	722.08	.0	.0	.0	18.0	483.0	33.70	.00	.901
.00	.000	2.435	14.153	5.943	715.88	.0	.0	.0	16.5	522.0	33.90	.00	.921
.00	.000	4.104	2.683	133.990	626.57	.0	.0	.0	14.0	508.0	29.24	.00	.962
.00	.000	3.681	1.698	157.816	595.12	.0	.0	.0	13.0	500.0	29.08	.00	.998

EPA/VW PRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

MAPPING AT 60 REV/SEC E.O.I. 330 ATDCF

REFER TO FIGURE NOS. 104-109

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
13	2	86	75.00	766.49	9.00	16.50	0	0.	1

1 ENGINE SPEED (REV/S)	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00
28 IGNITION TIMING	25.00	25.00	25.00	24.50	23.50	22.50	22.00	21.00	19.50	18.50	15.00
4 FUEL VOLUME (CC)	102.50	102.50	102.50	203.00	203.00	203.00	203.00	304.00	304.00	304.00	507.00
2 BRAKE LOAD	5.50	11.30	23.30	34.80	47.60	58.30	69.20	82.40	94.20	104.80	118.60
5 FUEL TIME (SEC)	54.80	47.70	37.90	61.60	51.70	44.90	39.90	51.10	45.90	41.60	51.50
6 FUEL TEMPERATURE (C)	10.00	10.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
8 AIR METER TEMPERATURE (C)	11.00	11.00	11.00	12.00	12.00	12.00	13.00	13.00	12.00	13.00	12.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-482.03	-438.42	-363.97	-294.78	-211.31	-139.87	-84.98	-73.70	-64.67	-48.13	-3.01
26 EXHAUST TEMP. (POST TURBO)	399.0	415.0	431.0	452.0	475.0	496.0	511.0	544.0	570.0	603.0	555.0
27 EXHAUST PRESSURE (POST TURBO)	11.3	15.8	24.1	32.3	45.1	57.2	67.7	72.2	77.5	81.2	100.0
13 CARBON MONOXIDE (%)	.185	.155	.130	.124	.129	.125	.124	.115	.106	1.300	5.500
15 CARBON DIOXIDE (%)	9.900	9.900	9.900	9.900	9.900	9.900	10.100	12.000	13.500	14.400	11.500
16 OXYGEN (%)	6.900	7.000	7.000	7.000	7.000	7.000	6.700	4.500	2.600	.600	.300
12 HYDROCARBONS (PPMC)	2520.0	2160.0	2160.0	1530.0	1500.0	1290.0	1110.0	780.0	600.0	780.0	2220.0
14 OXIDES OF NITROGEN (PPM)	-85.0	-80.0	-120.0	-150.0	-190.0	-210.0	-300.0	-1500.0	-2400.0	-2050.0	-340.0

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)
M.E.C./BOSCH IGNITION - CORRECT INJECTORS
MAPPING AT 60 REV/SEC E.O.I. 330 ATDCF

REFER TO FIGURE NOS. 104-109

DATE 13/ 2/86 TEST NO. 75.0 BAROMETER 766.49 MM.HG WET BULB TEMP(C) 9.0 DRY BULB TEMP(C) 16.5
RELATIVE HUMIDITY = 33.95
HUMIDITY CORRECTION FACTOR = .79 GRAINS OF WATER/LB DRY AIR = 27.30

SPEED	POWER-(KW)		BMEP-(bar)		TORQUE-(NM)		FUEL-CONSUMPTION			BSFC	BOSCH	CELESCO	CORRECTED
REV/S	UN.CORR	CORR	UN.CORR	CORR	UN.CORR	CORR	G/HR	MM3/INJ	MG/LITRE	G/KW.H	SMOKE	SMOKE	AIR FLOW(SEAT)
60.00	2.07	2.07	.47	.47	5.50	5.50	5378.	15.59	34.16	2593.6	.0	.0	.0000
60.00	4.26	4.26	.97	.97	11.30	11.30	6178.	17.91	39.25	1450.2	.0	.0	.0000
60.00	8.78	8.78	2.01	2.01	23.30	23.30	7768.	22.54	49.35	884.4	.0	.0	.0000
60.00	13.12	13.12	3.00	3.00	34.80	34.80	9466.	27.46	60.13	721.5	.0	.0	.0000
60.00	17.94	17.94	4.10	4.10	47.60	47.60	11279.	32.72	71.65	628.5	.0	.0	.0000
60.00	21.98	21.98	5.03	5.03	58.30	58.30	12987.	37.68	82.50	590.9	.0	.0	.0000
60.00	26.09	26.09	5.97	5.97	69.20	69.20	14614.	42.40	92.84	560.2	.0	.0	.0000
60.00	31.06	31.06	7.10	7.10	82.40	82.40	17089.	49.58	108.55	550.1	.0	.0	.0000
60.00	35.51	35.51	8.12	8.12	94.20	94.20	19024.	55.19	120.85	535.7	.0	.0	.0000
60.00	39.51	39.51	9.04	9.04	104.80	104.80	20991.	60.90	133.34	531.3	.0	.0	.0000
60.00	44.71	44.71	10.22	10.22	118.60	118.60	28278.	82.04	179.64	632.5	.0	.0	.0000

MAN.PRES	MAN.TEMP	INTAKE-AIR-(M3/S)		AIR-MASS	FREE-AIR-VOL.EFF.		VOL.EFF.	MANIFOLD-VOL.EFF.		AIR/FUEL-RATIO		EQUIVALENCE-RATIO	
MM.HG	C	FREE	AFT.MET	KG/S	AIR-MET.	SPINDT	AFT.MET	AIR-MET.	SPINDT	AIR-MET.	SPINDT	AIR-MET.	EMISSIONS
-482.03	.0	.0000	.0000	.0000	.00	24.80	.00	.00	64.24	.00	9.10	.000	.707
-438.42	.0	.0000	.0000	.0000	.00	28.78	.00	.00	74.55	.00	9.19	.000	.700
-363.97	.0	.0000	.0000	.0000	.00	36.25	.00	.00	93.90	.00	9.21	.000	.699
-294.78	.0	.0000	.0000	.0000	.00	44.62	.00	.00	115.17	.00	9.27	.000	.695
-211.31	.0	.0000	.0000	.0000	.00	53.17	.00	.00	137.23	.00	9.27	.000	.695
-139.87	.0	.0000	.0000	.0000	.00	61.36	.00	.00	158.38	.00	9.29	.000	.693
-84.98	.0	.0000	.0000	.0000	.00	68.08	.00	.00	175.11	.00	9.13	.000	.705
-73.70	.0	.0000	.0000	.0000	.00	69.51	.00	.00	178.79	.00	7.97	.000	.808
-64.67	.0	.0000	.0000	.0000	.00	69.89	.00	.00	180.39	.00	7.22	.000	.891
-48.13	.0	.0000	.0000	.0000	.00	67.45	.00	.00	173.50	.00	6.30	.000	1.023
-3.01	.0	.0000	.0000	.0000	.00	75.15	.00	.00	193.98	.00	5.23	.000	1.232

HC-PPM	HC-PPM	H C	NOX-PPM	NOX-PPM	NOX-PPM	NOX	CO-PPM	CO-PPM	C O	CO2-(%)	CO2-(%)	CO2	O 2
WET	DRY	G/H	WET	DRY	DRY.COR.	G/H	WET	DRY	G/H	WET	DRY	G/H	%
2100.2	2520.0	65.55	85.0	102.0	80.1	5.99	1541.8	1850.0	84.17	8.25	9.90	7077.0	6.90
1800.8	2160.0	64.96	80.0	96.0	75.4	6.52	1292.2	1550.0	81.54	8.25	9.90	8182.6	7.00
1801.3	2160.0	81.88	120.0	143.9	113.1	12.32	1084.1	1300.0	86.20	8.26	9.90	10314.2	7.00
1276.0	1530.0	71.15	150.0	179.9	141.3	18.88	1034.2	1240.0	100.87	8.26	9.90	12053.2	7.00
1250.9	1500.0	83.10	190.0	227.8	179.0	28.50	1075.8	1290.0	125.00	8.26	9.90	15073.2	7.00
1075.8	1290.0	82.49	210.0	251.8	197.9	36.35	1042.5	1250.0	139.81	8.26	9.90	17398.7	7.00
922.7	1110.0	78.48	300.0	360.9	283.6	57.61	1030.7	1240.0	153.34	8.40	10.10	19624.7	6.70
628.7	780.0	54.66	1500.0	1861.0	1462.3	294.41	926.9	1150.0	140.95	9.67	12.00	23109.6	4.50
472.3	600.0	41.76	2400.0	3048.8	2395.7	479.09	834.4	1060.0	129.05	10.63	13.50	25823.9	2.60
597.9	780.0	51.88	2050.0	2674.5	2101.6	401.66	9964.3	13000.0	1512.52	11.04	14.40	26324.5	.60
1710.9	2220.0	182.25	340.0	441.2	346.7	81.77	42386.0	55000.0	7897.87	8.86	11.50	25946.8	.30

PARTICULATES		H C	NOX	C O	CO2	START	END	START	IGNITION	EXHAUST	BRAKE	E.G.R.	BOOST PRESS.
G/H	G/KW.H	G/KW.H	G/KW.H	G/KW.H	G/KW.H	INJ.	INJ.	COMB.	TIMING	TEMP.C	THERM.EFF	(%)	RATIO
.00	.000	31.613	2.889	40.593	3413.14	.0	.0	.0	25.0	399.0	6.96	.00	.371
.00	.000	15.249	1.529	19.140	1920.80	.0	.0	.0	25.0	415.0	12.45	.00	.428
.00	.000	9.322	1.402	9.813	1174.22	.0	.0	.0	25.0	431.0	20.41	.00	.525
.00	.000	5.424	1.439	7.688	964.47	.0	.0	.0	24.5	452.0	25.02	.00	.615
.00	.000	4.631	1.568	6.966	839.98	.0	.0	.0	23.5	475.0	28.72	.00	.724
.00	.000	3.753	1.654	6.361	791.62	.0	.0	.0	22.5	496.0	30.55	.00	.818
.00	.000	3.008	2.208	5.878	752.26	.0	.0	.0	22.0	511.0	32.23	.00	.889

REFER TO FIGURE NOS. 104-109

.00	.000	1.759	9.478	4.537	743.93	.0	.0	.0	21.0	544.0	32.82	.00	.904
.00	.000	1.176	13.491	3.634	727.18	.0	.0	.0	19.5	570.0	33.70	.00	.916
.00	.000	1.313	10.166	38.283	666.30	.0	.0	.0	18.5	603.0	33.98	.00	.937
.00	.000	4.076	1.829	176.642	580.32	.0	.0	.0	15.0	555.0	28.55	.00	.996

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

MAPPING AT 80 REV/SEC E.O.I. 330 ATDCF

REFER TO FIGURE NOS. 104-109

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
13	2	86	76.00	766.49	9.00	16.50	0	0.	1

1 ENGINE SPEED (REV/S)	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00
28 IGNITION TIMING	27.00	27.00	27.00	26.50	25.00	21.50	21.00	20.50	19.50	17.00
4 FUEL VOLUME (CC)	102.50	203.00	203.00	203.00	304.00	304.00	304.00	304.00	507.00	507.00
2 BRAKE LOAD	11.30	23.40	35.10	47.10	58.30	69.70	83.30	93.60	105.10	117.60
5 FUEL TIME (SEC)	33.00	51.80	43.10	36.50	47.60	42.00	37.00	53.50	48.60	56.00
6 FUEL TEMPERATURE (C)	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
8 AIR METER TEMPERATURE (C)	13.00	13.00	12.00	13.00	13.00	13.00	14.00	15.00	16.00	16.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-430.90	-359.46	-285.76	-213.57	-143.63	-81.97	-71.44	-63.92	-48.88	-6.02
26 EXHAUST TEMP. (POST TURBO)	457.0	490.0	507.0	529.0	542.0	565.0	605.0	641.0	667.0	636.0
27 EXHAUST PRESSURE (POST TURBO)	31.6	45.9	64.7	86.5	107.0	133.9	142.9	150.4	169.2	201.5
13 CARBON MONOXIDE (%)	.155	.130	.131	.124	.125	.123	.116	.145	1.100	6.000
15 CARBON DIOXIDE (%)	9.800	9.900	9.900	9.900	9.900	10.500	11.900	13.400	14.300	11.500
16 OXYGEN (%)	7.000	7.000	7.100	7.000	7.000	6.700	4.500	2.600	.600	.200
12 HYDROCARBONS (PPMC)	1680.0	1560.0	1500.0	1200.0	1080.0	840.0	480.0	450.0	960.0	2610.0
14 OXIDES OF NITROGEN (PPM)	-110.0	-170.0	-215.0	-316.0	-340.0	-510.0	-1500.0	-2450.0	-2300.0	-300.0

EPA/VW HRCC METHANOL (79.5mm x 73.4mm)
M.F.C./BOSCH IGNITION - CORRECT INJECTORS
MAPPING AT 80 REV/SEC E.O.I. 330 ATDCF

REFER TO FIGURE NOS. 10

DATE 13/ 2/86 TEST NO. 76.0 BAROMETER 766.49 MM.HG WET BULB TEMP(C) 9.0 DRY BULB TEMP(C) 16.5
RELATIVE HUMIDITY = 33.95
HUMIDITY CORRECTION FACTOR = .79 GRAINS OF WATER/LB DRY AIR = 27.30

SPEED	POWER-(KW)		BMEP-(bar)		TORQUE-(NM)		FUEL-CONSUMPTION			BSFC	BOSCH	CELESCO	CORRECTED
REV/S	UN.CORR	CORR	UN.CORR	CORR	UN.CORR	CORR	G/HR	MM3/INJ	MG/LITRE	G/KW.H	SMOKE	SMOKE	AIR FLOW(SEA)]
80.00	5.68	5.68	.97	.97	11.30	11.30	8922.	19.41	42.51	1570.8	.0	.0	.0000
80.00	11.76	11.76	2.02	2.02	23.40	23.40	11257.	24.49	53.63	957.0	.0	.0	.0000
80.00	17.64	17.64	3.03	3.03	35.10	35.10	13529.	29.44	64.46	766.8	.0	.0	.0000
80.00	23.68	23.68	4.06	4.06	47.10	47.10	15976.	34.76	76.11	674.8	.0	.0	.0000
80.00	29.30	29.30	5.03	5.03	58.30	58.30	18345.	39.92	87.40	626.0	.0	.0	.0000
80.00	35.04	35.04	6.01	6.01	69.70	69.70	20791.	45.24	99.06	593.4	.0	.0	.0000
80.00	41.87	41.87	7.18	7.18	83.30	83.30	23601.	51.35	112.44	563.6	.0	.0	.0000
80.00	47.05	47.05	8.07	8.07	93.60	93.60	26066.	56.72	124.19	554.0	.0	.0	.0000
80.00	52.83	52.83	9.06	9.06	105.10	105.10	29966.	65.20	142.77	567.2	.0	.0	.0000
80.00	59.11	59.11	10.14	10.14	117.60	117.60	40454.	88.02	192.73	684.4	.0	.0	.0000

MAN.PRES	MAN.TEMP	INTAKE-AIR-(M3/S)		AIR-MASS	FREE-AIR-VOL.EFF.		VOL.EFF.	MANIFOLD-VOL.EFF.		AIR/FUEL-RATIO		EQUIVALENCE-RATIO	
MM.HG	C	FREE	AFT.MET	KG/S	AIR-MET.	SPINDT	AFT.MET	AIR-MET.	SPINDT	AIR-MET.	SPINDT	AIR-MET.	EMISSIONS
-430.90	.0	.0000	.0000	.0000	.00	31.63	.00	.00	68.97	.00	9.26	.000	.695
-359.46	.0	.0000	.0000	.0000	.00	39.91	.00	.00	87.01	.00	9.26	.000	.695
-285.76	.0	.0000	.0000	.0000	.00	48.04	.00	.00	105.11	.00	9.31	.000	.692
-213.57	.0	.0000	.0000	.0000	.00	56.87	.00	.00	123.99	.00	9.30	.000	.692
-143.63	.0	.0000	.0000	.0000	.00	65.38	.00	.00	142.55	.00	9.31	.000	.691
-81.97	.0	.0000	.0000	.0000	.00	72.05	.00	.00	157.07	.00	9.05	.000	.711
-71.44	.0	.0000	.0000	.0000	.00	72.54	.00	.00	157.60	.00	8.00	.000	.805
-63.92	.0	.0000	.0000	.0000	.00	72.59	.00	.00	157.16	.00	7.23	.000	.891
-48.88	.0	.0000	.0000	.0000	.00	73.41	.00	.00	158.39	.00	6.33	.000	1.016
-6.02	.0	.0000	.0000	.0000	.00	79.92	.00	.00	172.43	.00	5.11	.000	1.261

HC-PPM	HC-PPM	H C	NOX-PPM	NOX-PPM	NOX-PPM	NOX	CO-PPM	CO-PPM	C O	CO2-(%)	CO2-(%)	CO2	O 2
WET	DRY	G/H	WET	DRY	DRY.COR.	G/H	WET	DRY	G/H	WET	DRY	G/H	%
1402.9	1680.0	74.03	110.0	131.7	103.5	13.11	1294.4	1550.0	119.47	8.18	9.80	11868.5	7.00
1300.9	1560.0	86.20	170.0	203.9	160.2	25.43	1084.1	1300.0	125.64	8.26	9.90	15033.7	7.00
1250.9	1500.0	99.66	215.0	257.8	202.6	38.67	1092.4	1310.0	152.24	8.26	9.90	18077.2	7.10
1000.8	1200.0	94.49	310.0	371.7	292.1	66.08	1034.2	1240.0	170.78	8.26	9.90	21423.8	7.00
900.7	1080.0	97.76	340.0	407.7	320.4	83.32	1042.5	1250.0	197.91	8.26	9.90	24628.2	7.00
693.7	840.0	81.55	510.0	617.6	485.3	135.37	1015.7	1230.0	208.88	8.67	10.50	28016.5	6.70
387.5	480.0	46.95	1500.0	1858.0	1460.0	410.30	936.5	1160.0	198.46	9.61	11.90	31986.7	4.50
354.6	450.0	43.15	2450.0	3108.7	2442.8	673.09	1142.7	1450.0	243.22	10.56	13.40	35316.9	2.60
738.5	960.0	92.82	2300.0	2989.9	2349.4	652.66	8461.8	11000.0	1860.27	11.00	14.30	37997.6	.60
2003.0	2610.0	297.23	300.0	390.9	307.2	100.51	46046.7	60000.0	11951.42	8.83	11.50	35991.9	.20

PARTICULATES		H C	NOX	C O	CO2	START	END	START	IGNITION	EXHAUST	BRAKE	E.G.R.	BOOST PRESS.
G/H	G/KW.H	G/KW.H	G/KW.H	G/KW.H	G/KW.H	INJ.	INJ.	COMB.	TIMING	TEMP.C	THERM.EFF	(%)	RATIO
.00	.000	13.034	2.307	21.034	2089.52	.0	.0	.0	27.0	457.0	11.49	.00	.438
.00	.000	7.328	2.162	10.682	1278.15	.0	.0	.0	27.0	490.0	18.86	.00	.531
.00	.000	5.649	2.192	8.629	1024.60	.0	.0	.0	27.0	507.0	23.54	.00	.627
.00	.000	3.991	2.791	7.214	904.91	.0	.0	.0	26.5	529.0	26.76	.00	.721
.00	.000	3.336	2.843	6.754	840.42	.0	.0	.0	25.0	542.0	28.84	.00	.813
.00	.000	2.328	3.864	5.962	799.67	.0	.0	.0	21.5	565.0	30.42	.00	.893
.00	.000	1.121	9.799	4.740	763.98	.0	.0	.0	21.0	605.0	32.03	.00	.907
.00	.000	.917	14.306	5.170	750.65	.0	.0	.0	20.5	641.0	32.59	.00	.917
.00	.000	1.757	12.354	35.213	719.26	.0	.0	.0	19.5	667.0	31.83	.00	.936
.00	.000	5.028	1.700	202.182	608.87	.0	.0	.0	17.0	636.0	26.38	.00	.992

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

MAPPING AT 20 REV/SEC WITH AUTO E.G.R.

REFER TO FIGURE NOS. 110-116

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
28	2	86	77.00	763.64	9.50	18.00	0	0.	1

1 ENGINE SPEED (REV/S)	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
28 IGNITION TIMING	21.00	21.00	21.00	20.00	9.50	7.30	6.60	5.90	5.00
4 FUEL VOLUME (CC)	52.00	52.00	52.00	52.00	52.00	52.00	102.50	102.50	102.50
2 BRAKE LOAD	5.50	11.30	23.00	35.60	46.70	58.80	69.30	81.40	93.60
5 FUEL TIME (SEC)	95.00	78.10	60.40	48.80	38.90	34.20	56.00	49.30	39.60
6 FUEL TEMPERATURE (C)	15.00	17.00	15.00	15.00	14.00	14.00	14.00	14.00	14.00
8 AIR METER TEMPERATURE (C)	14.00	14.00	12.00	12.00	16.00	16.00	15.00	15.00	16.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-497.82	-425.63	-313.58	-227.86	-148.90	-90.99	-67.68	-44.37	-.75
26 EXHAUST TEMP. (POST TURBO)	211.0	213.0	236.0	260.0	307.0	317.0	336.0	360.0	360.0
27 EXHAUST PRESSURE (POST TURBO)	3.0	3.0	3.0	5.3	6.8	9.0	11.3	14.3	15.0
13 CARBON MONOXIDE (%)	.185	.192	.168	.138	.148	.145	.140	.700	3.200
15 CARBON DIOXIDE (%)	11.500	11.600	11.500	11.500	13.300	13.500	14.200	14.600	13.300
16 OXYGEN (%)	4.900	4.700	4.700	4.800	2.600	2.500	1.200	.500	.200
12 HYDROCARBONS (PPMC)	3060.0	2760.0	2430.0	1890.0	2160.0	1740.0	1350.0	1560.0	2190.0
14 OXIDES OF NITROGEN (PPM)	-56.0	-24.0	-36.0	-80.0	-220.0	-360.0	-1050.0	-1420.0	-420.0
17 INTAKE MANIFOLD CO2 (%)	.020	1.400	1.520	1.500	1.670	1.180	.780	.020	.020
30 AMBIENT CO2 (%)	.020	.020	.020	.020	.020	.020	.020	.020	.020

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)
H.E.C./BOSCH IGNITION - CORRECT INJECTORS
MAPPING AT 20 REV/SEC WITH AUTO E.G.R.

REFER TO FIGURE NOS. 110-116

DATE 28/ 2/86 TEST NO. 77.0 BAROMETER 763.64 MM.HG WET BULB TEMP(C) 9.5 DRY BULB TEMP(C) 18.0
RELATIVE HUMIDITY = 29.59
HUMIDITY CORRECTION FACTOR = .78 GRAINS OF WATER/LB DRY AIR = 26.25

SPEED	POWER-(KW)		BMEP-(bar)		TORQUE-(NM)		FUEL-CONSUMPTION			BSFC	BOSCH	CELESCO	CORRECTED
REV/S	UN.CORR	CORR	UN.CORR	CORR	UN.CORR	CORR	G/HR	MM3/INJ	MG/LITRE	G/KW.H	SMOKE	SMOKE	AIR FLOW(SEAI)
20.00	.69	.69	.47	.47	5.50	5.50	1567.	13.68	29.85	2266.6	.0	.0	.0000
20.00	1.42	1.42	.97	.97	11.30	11.30	1902.	16.65	36.25	1339.5	.0	.0	.0000
20.00	2.89	2.89	1.98	1.98	23.00	23.00	2464.	21.52	46.96	852.5	.0	.0	.0000
20.00	4.47	4.47	3.07	3.07	35.60	35.60	3050.	26.64	58.12	681.7	.0	.0	.0000
20.00	5.87	5.87	4.03	4.03	46.70	46.70	3829.	33.42	72.98	652.5	.0	.0	.0000
20.00	7.39	7.39	5.07	5.07	58.80	58.80	4356.	38.01	83.00	589.5	.0	.0	.0000
20.00	8.71	8.71	5.97	5.97	69.30	69.30	5243.	45.76	99.92	602.1	.0	.0	.0000
20.00	10.23	10.23	7.02	7.02	81.40	81.40	5956.	51.98	113.50	582.2	.0	.0	.0000
20.00	11.76	11.76	8.07	8.07	93.60	93.60	7415.	64.71	141.30	630.4	.0	.0	.0000

MAN.PRES	MAN.TEMP	INTAKE-AIR-(M3/S)		AIR-MASS	FREE-AIR-VOL.EFF.		VOL.EFF.	MANIFOLD-VOL.EFF.		AIR/FUEL-RATIO		EQUIVALENCE-RATIO	
MM.HG	C	FREE	AFT.MET	KG/S	AIR-MET.	SPINDT	AFT.MET	AIR-MET.	SPINDT	AIR-MET.	SPINDT	AIR-MET.	EMISSIONS
-497.82	.0	.0000	.0000	.0000	.00	19.29	.00	.00	52.71	.00	7.99	.000	.806
-425.63	.0	.0000	.0000	.0000	.00	23.22	.00	.00	63.46	.00	7.92	.000	.813
-313.58	.0	.0000	.0000	.0000	.00	30.04	.00	.00	82.67	.00	7.96	.000	.809
-227.86	.0	.0000	.0000	.0000	.00	37.58	.00	.00	103.42	.00	8.05	.000	.800
-148.90	.0	.0000	.0000	.0000	.00	42.35	.00	.00	114.94	.00	7.12	.000	.904
-90.99	.0	.0000	.0000	.0000	.00	48.06	.00	.00	130.41	.00	7.11	.000	.906
-67.68	.0	.0000	.0000	.0000	.00	54.45	.00	.00	148.28	.00	6.71	.000	.959
-44.37	.0	.0000	.0000	.0000	.00	58.68	.00	.00	159.79	.00	6.37	.000	1.011
-.75	.0	.0000	.0000	.0000	.00	65.84	.00	.00	178.68	.00	5.72	.000	1.126

HC-PPM	HC-PPM	H C	NOX-PPM	NOX-PPM	NOX-PPM	NOX	CO-PPM	CO-PPM	C O	CO2-(%)	CO2-(%)	CO2	H 2
WET	DRY	G/H	WET	DRY	DRY.COR.	G/H	WET	DRY	G/H	WET	DRY	G/H	%
2484.5	3060.0	19.99	56.0	69.0	53.8	1.01	1502.0	1850.0	21.14	9.34	11.50	2064.5	4.90
2237.1	2760.0	21.75	24.0	29.6	23.1	.52	1556.2	1920.0	26.47	9.40	11.60	2512.3	4.70
1973.3	2430.0	25.13	36.0	44.3	34.6	1.03	1364.3	1680.0	30.39	9.34	11.50	3266.9	4.70
1535.3	1890.0	24.37	80.0	98.5	76.8	2.05	1121.0	1380.0	31.12	9.34	11.50	4074.7	4.80
1705.0	2160.0	30.27	220.0	278.7	217.5	8.75	1168.2	1480.0	36.27	10.50	13.30	5121.7	2.60
1369.2	1740.0	27.42	380.0	482.9	376.8	17.06	1141.0	1450.0	39.97	10.62	13.50	5846.8	2.50
1050.9	1350.0	24.45	1050.0	1348.9	1052.4	54.76	1089.8	1400.0	44.35	11.05	14.20	7067.9	1.20
1199.6	1560.0	30.06	1420.0	1846.6	1440.7	79.75	5382.9	7000.0	235.90	11.23	14.60	7730.6	.50
1675.3	2190.0	48.56	420.0	549.0	428.3	27.29	24479.3	32000.0	1241.12	10.17	13.30	8105.0	.20

PARTICULATES		H C	NOX	C O	CO2	START	END	START	IGNITION	EXHAUST	BRAKE	E.G.R.	BOOST PRESS.
G/H	G/KW.H	G/KW.H	G/KW.H	G/KW.H	G/KW.H	INJ.	INJ.	COMB.	TIMING	TEMP.C	THERM.EFF	(%)	RATIO
.00	.000	28.920	1.461	30.582	2987.01	.0	.0	.0	21.0	211.0	7.97	.00	.348
.00	.000	15.317	.368	18.637	1769.22	.0	.0	.0	21.0	213.0	13.48	11.90	.443
.00	.000	8.696	.356	10.516	1131.01	.0	.0	.0	21.0	236.0	21.18	13.04	.569
.00	.000	5.447	.636	6.956	910.82	.0	.0	.0	20.0	260.0	26.48	12.87	.702
.00	.000	5.157	1.492	6.181	872.74	.0	.0	.0	9.5	307.0	27.67	12.41	.805
.00	.000	3.711	2.309	5.409	791.28	.0	.0	.0	7.3	317.0	30.63	8.59	.881
.00	.000	2.808	6.288	5.093	811.61	.0	.0	.0	6.6	336.0	29.99	5.35	.911
.00	.000	2.938	7.796	23.062	755.76	.0	.0	.0	5.9	360.0	31.01	.00	.942
.00	.000	4.129	2.320	105.518	689.08	.0	.0	.0	5.0	360.0	28.64	.00	.999

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

MAPPING AT 40 REV/SEC WITH AUTO E.G.R.

REFER TO FIGURE NOS. 110-116

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGER OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
28	2	86	78.00	763.64	9.50	18.00	0	0.	1

1 ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
28 IGNITION TIMING	21.00	21.00	21.00	21.00	11.80	10.80	9.90	9.40	8.70	6.60
4 FUEL VOLUME (CC)	52.00	52.00	102.50	102.50	102.50	102.50	203.00	203.00	203.00	203.00
2 BRAKE LOAD	5.90	11.90	23.80	34.60	46.60	56.80	69.30	81.50	93.70	104.50
5 FUEL TIME (SEC)	45.90	39.50	58.40	47.80	38.30	32.30	58.00	49.70	40.50	33.10
6 FUEL TEMPERATURE (C)	10.00	10.00	10.00	10.00	14.00	14.00	14.00	14.00	14.00	14.00
8 AIR METER TEMPERATURE (C)	13.00	13.00	14.00	14.00	18.00	20.00	19.00	19.00	18.00	19.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-485.79	-439.92	-356.45	-265.46	-158.67	-115.81	-81.97	-63.92	-36.85	-13.54
26 EXHAUST TEMP. (POST TURBO)	321.0	334.0	365.0	383.0	413.0	448.0	479.0	505.0	502.0	492.0
27 EXHAUST PRESSURE (POST TURBO)	5.3	6.0	7.5	12.0	15.8	19.6	24.1	30.1	36.1	40.6
13 CARBON MONOXIDE (%)	.204	.162	.162	.145	.145	.158	.170	1.000	3.700	6.000
15 CARBON DIOXIDE (%)	11.700	11.500	13.600	12.500	12.000	13.100	13.800	14.600	12.800	11.400
16 OXYGEN (%)	4.500	4.600	2.400	3.300	4.100	2.900	2.100	.500	.200	.200
12 HYDROCARBONS (PPMC)	2130.0	1830.0	1680.0	2040.0	2280.0	2160.0	1710.0	1830.0	2340.0	3120.0
14 OXIDES OF NITROGEN (PPM)	-40.0	-54.0	-82.0	-130.0	-100.0	-270.0	-450.0	-680.0	-380.0	-160.0
17 INTAKE MANIFOLD CO2 (%)	1.000	1.420	2.100	1.920	1.460	1.300	1.040	.700	.180	.020
30 AMBIENT CO2 (%)	.020	.020	.020	.020	.020	.020	.020	.020	.020	.020

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)
H.E.C./BOSCH IGNITION - CORRECT INJECTORS
MAPPING AT 40 REV/SEC WITH AUTO E.G.R.

REFER TO FIGURE NOS. 110-116

DATE 28/ 2/86 TEST NO. 78.0 BAROMETER 763.64 MM.HG WET BULB TEMP(C) 9.5 DRY BULB TEMP(C) 18.0
RELATIVE HUMIDITY = 29.59
HUMIDITY CORRECTION FACTOR = .78 GRAINS OF WATER/LB DRY AIR = 26.25

SPEED	POWER-(KW)		BMEP-(bar)		TORQUE-(NM)		FUEL-CONSUMPTION			BSFC	BOSCH	CELESCO	CORRECTED
REV/S	UN.CORR	CORR	UN.CORR	CORR	UN.CORR	CORR	G/HR	MM3/INJ	MG/LITRE	G/KW.H	SMOKE	SMOKE	AIR FLOW(SEAT)
40.00	1.48	1.48	.51	.51	5.90	5.90	3257.	14.16	31.04	2196.6	.0	.0	.0000
40.00	2.99	2.99	1.03	1.03	11.90	11.90	3785.	16.46	36.06	1265.5	.0	.0	.0000
40.00	5.98	5.98	2.05	2.05	23.80	23.80	5046.	21.94	48.08	843.6	.0	.0	.0000
40.00	8.70	8.70	2.98	2.98	34.60	34.60	6165.	26.80	58.75	709.0	.0	.0	.0000
40.00	11.71	11.71	4.02	4.02	46.60	46.60	7666.	33.45	73.05	654.6	.0	.0	.0000
40.00	14.78	14.78	5.07	5.07	58.80	58.80	9090.	39.67	86.62	615.1	.0	.0	.0000
40.00	17.42	17.42	5.97	5.97	69.30	69.30	10026.	43.75	95.54	575.7	.0	.0	.0000
40.00	20.48	20.48	7.03	7.03	81.50	81.50	11701.	51.06	111.49	571.2	.0	.0	.0000
40.00	23.55	23.55	8.08	8.08	93.70	93.70	14358.	62.65	136.82	609.7	.0	.0	.0000
40.00	26.26	26.26	9.01	9.01	104.50	104.50	17568.	76.66	167.40	668.9	.0	.0	.0000

MAN.PRES	MAN.TEMP	INTAKE-AIR-(M3/S)		AIR-MASS	FREE-AIR-VOL.EFF.		VOL.EFF.	MANIFOLD-VOL.EFF.		AIR/FUEL-RATIO		EQUIVALENCE-RATIO	
MM.HG	C	FREE	AFT.MET	KG/S	AIR-MET.	SPINDT	AFT.MET	AIR-MET.	SPINDT	AIR-MET.	SPINDT	AIR-MET.	EMISSIONS
-485.79	.0	.0000	.0000	.0000	.00	19.70	.00	.00	51.68	.00	7.87	.000	.818
-439.92	.0	.0000	.0000	.0000	.00	23.17	.00	.00	60.80	.00	7.97	.000	.808
-356.45	.0	.0000	.0000	.0000	.00	27.49	.00	.00	71.87	.00	7.07	.000	.911
-265.46	.0	.0000	.0000	.0000	.00	35.21	.00	.00	92.05	.00	7.41	.000	.869
-158.67	.0	.0000	.0000	.0000	.00	46.21	.00	.00	119.16	.00	7.71	.000	.835
-115.81	.0	.0000	.0000	.0000	.00	51.71	.00	.00	132.42	.00	7.23	.000	.891
-81.97	.0	.0000	.0000	.0000	.00	54.77	.00	.00	140.74	.00	6.96	.000	.925
-63.92	.0	.0000	.0000	.0000	.00	57.69	.00	.00	148.25	.00	6.29	.000	1.024
-36.85	.0	.0000	.0000	.0000	.00	62.83	.00	.00	162.00	.00	5.60	.000	1.150
-13.54	.0	.0000	.0000	.0000	.00	70.07	.00	.00	180.06	.00	5.08	.000	1.266

HC-PPM	HC-PPM	H C	NOX-PPM	NOX-PPM	NOX-PPM	NOX	CO-PPM	CO-PPM	C O	CO2-(%)	CO2-(%)	CO2	O 2
WET	DRY	G/H	WET	DRY	DRY.COR.	G/H	WET	DRY	G/H	WET	DRY	G/H	%
1723.4	2130.0	28.63	40.0	49.4	38.6	1.49	1650.6	2040.0	47.96	9.47	11.70	4321.6	4.50
1486.2	1830.0	29.24	54.0	66.5	51.9	2.38	1315.7	1620.0	45.27	9.34	11.50	5049.3	4.60
1319.7	1680.0	30.43	82.0	104.4	81.4	4.24	1272.5	1620.0	51.32	10.68	13.60	6769.6	2.40
1630.8	2040.0	48.94	130.0	162.6	126.9	8.75	1159.1	1450.0	60.84	9.99	12.50	8241.4	3.30
1837.2	2280.0	70.63	100.0	124.1	96.8	8.62	1168.4	1450.0	78.57	9.67	12.00	10216.6	4.10
1710.1	2160.0	72.86	270.0	341.0	266.1	25.79	1250.9	1580.0	93.22	10.37	13.10	12144.5	2.90
1338.9	1710.0	60.62	450.0	574.7	448.4	45.67	1331.1	1700.0	105.41	10.81	13.80	13444.7	2.10
1402.8	1830.0	67.83	680.0	887.1	692.1	73.70	7665.5	10000.0	648.33	11.19	14.60	14672.6	.50
1795.5	2340.0	100.39	380.0	495.2	386.4	47.63	28389.8	37000.0	2776.43	9.82	12.80	15091.5	.20
2398.3	3120.0	154.73	160.0	208.1	162.4	23.14	46120.9	60000.0	5204.70	8.76	11.40	15537.7	.20

PARTICULATES		H C	NOX	C O	CO2	START	END	START	IGNITION	EXHAUST	BRAKE	E.G.R.	BOOST PRESS.
G/H	G/KW.H	G/KW.H	G/KW.H	G/KW.H	G/KW.H	INJ.	INJ.	COMB.	TIMING	TEMP.C	THERM.EFF	(%)	RATIO
.00	.000	19.306	1.004	32.341	2914.43	.0	.0	.0	21.0	321.0	8.22	8.36	.364
.00	.000	9.776	.796	15.136	1688.29	.0	.0	.0	21.0	334.0	14.27	12.17	.424
.00	.000	5.087	.709	8.580	1131.74	.0	.0	.0	21.0	365.0	21.40	15.29	.533
.00	.000	5.628	1.006	6.997	947.73	.0	.0	.0	21.0	383.0	25.47	15.20	.652
.00	.000	6.031	.736	6.709	872.35	.0	.0	.0	11.8	413.0	27.58	12.00	.792
.00	.000	4.930	1.745	6.308	821.79	.0	.0	.0	10.8	448.0	29.35	9.77	.848
.00	.000	3.480	2.622	6.052	771.93	.0	.0	.0	9.9	479.0	31.36	7.39	.893
.00	.000	3.312	3.598	31.652	726.09	.0	.0	.0	9.4	505.0	31.61	4.66	.916
.00	.000	4.263	2.022	117.898	640.85	.0	.0	.0	8.7	502.0	29.61	1.25	.952
.00	.000	5.891	.881	198.171	591.61	.0	.0	.0	8.0	492.0	26.99	.00	.982

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

MAPPING AT 60 REV/SEC WITH AUTO E.G.R.

REFER TO FIGURE NOS. 110-116

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
28	2	86	79.00	763.64	9.50	18.00	0	0.	1

1 ENGINE SPEED (REV/S)	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00
28 IGNITION TIMING	24.00	24.00	24.00	23.50	13.40	11.20	10.20	10.00	10.00	10.00	10.00
4 FUEL VOLUME (CC)	102.50	102.50	102.50	203.00	203.00	203.00	203.00	304.00	304.00	304.00	304.00
2 BRAKE LOAD	6.10	11.30	23.30	34.60	46.60	58.60	69.30	81.80	93.50	103.40	112.30
5 FUEL TIME (SEC)	55.70	48.20	38.20	61.60	50.00	42.20	37.10	48.00	39.60	34.50	29.80
6 FUEL TEMPERATURE (C)	11.00	11.00	11.00	11.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00
8 AIR METER TEMPERATURE (C)	14.00	15.00	15.00	15.00	20.00	19.00	21.00	18.00	18.00	18.00	18.00
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-503.84	-460.22	-357.95	-259.44	-172.21	-127.84	-90.24	-74.45	-45.12	-26.32	-4.51
26 EXHAUST TEMP. (POST TURBO)	396.0	414.0	436.0	460.0	475.0	512.0	564.0	559.0	565.0	563.0	561.0
27 EXHAUST PRESSURE (POST TURBO)	7.5	11.3	16.5	24.1	33.1	41.4	51.9	57.9	73.7	85.7	102.3
13 CARBON MONOXIDE (%)	.175	.165	.158	.150	.130	.138	.165	1.300	3.900	5.200	6.500
15 CARBON DIOXIDE (%)	11.800	11.500	13.000	12.800	12.000	13.300	14.200	14.500	12.700	12.200	10.800
16 OXYGEN (%)	4.200	4.700	2.500	2.700	4.000	2.900	1.800	.300	.300	.200	.200
12 HYDROCARBONS (PPMC)	1080.0	1530.0	1380.0	1500.0	1740.0	1200.0	810.0	1050.0	1440.0	1560.0	2700.0
14 OXIDES OF NITROGEN (PPM)	-220.0	-125.0	-170.0	-200.0	-160.0	-290.0	-490.0	-540.0	-210.0	-200.0	-110.0
17 INTAKE MANIFOLD CO2 (%)	.080	.720	1.830	1.890	1.200	1.130	1.060	.880	.400	.020	.020
30 AMBIENT CO2 (%)	.020	.020	.020	.020	.020	.020	.020	.020	.020	.020	.020

EPA/VW HRCC METHANOL (79.5mm X 73.4mm)
N.E.C./BOSCH IGNITION - CORRECT INJECTORS
MAPPING AT 60 REV/SEC WITH AUTO E.G.R.

REFER TO FIGURE NOS. 110-116

DATE 28/ 2/86 TEST NO. 79.0 BAROMETER 763.64 MM.HG WET BULB TEMP(C) 9.5 DRY BULB TEMP(C) 18.0
RELATIVE HUMIDITY = 29.59
HUMIDITY CORRECTION FACTOR = .78 GRAINS OF WATER/LB DRY AIR = 26.25

SPEED REV/S	POWER-(KW) UN.CORR	POWER-(KW) CORR	BMEP-(bar) UN.CORR	BMEP-(bar) CORR	TORQUE-(NM) UN.CORR	TORQUE-(NM) CORR	FUEL-CONSUMPTION G/HR	FUEL-CONSUMPTION MM3/INJ	FUEL-CONSUMPTION MG/LITRE	BSFC G/KW.H	BOSCH SMOKE	CELESCO SMOKE	CORRECTED AIR FLOW(SEAT)
60.00	2.30	2.30	.53	.53	6.10	6.10	5286.	15.34	33.58	2298.6	.0	.0	.0000
60.00	4.26	4.26	.97	.97	11.30	11.30	6108.	17.72	38.80	1433.9	.0	.0	.0000
60.00	8.78	8.78	2.01	2.01	23.30	23.30	7707.	22.36	48.96	877.5	.0	.0	.0000
60.00	13.04	13.04	2.98	2.98	34.60	34.60	9466.	27.46	60.13	725.7	.0	.0	.0000
60.00	17.57	17.57	4.02	4.02	46.60	46.60	11630.	33.83	73.88	662.0	.0	.0	.0000
60.00	22.09	22.09	5.05	5.05	58.60	58.60	13780.	40.09	87.54	623.8	.0	.0	.0000
60.00	26.13	26.13	5.97	5.97	69.30	69.30	15674.	45.60	99.57	600.0	.0	.0	.0000
60.00	30.84	30.84	7.05	7.05	81.80	81.80	18143.	52.78	115.25	588.3	.0	.0	.0000
60.00	35.25	35.25	8.06	8.06	93.50	93.50	21991.	63.97	139.70	623.9	.0	.0	.0000
60.00	38.98	38.98	8.91	8.91	103.40	103.40	25242.	73.43	160.35	647.5	.0	.0	.0000
60.00	42.34	42.34	9.68	9.68	112.30	112.30	29223.	85.01	185.64	690.3	.0	.0	.0000

MAN.PRES MM.HG	MAN.TEMP C	INTAKE-AIR-(M3/S) FREE	INTAKE-AIR-(M3/S) AFT.MET	AIR-MASS KG/S	FREE-AIR-VOL.EFF. AIR-MET.	FREE-AIR-VOL.EFF. SPINDT	VOL.EFF. AFT.MET	MANIFOLD-VOL.EFF. AIR-MET.	MANIFOLD-VOL.EFF. SPINDT	AIR/FUEL-RATIO AIR-MET.	AIR/FUEL-RATIO SPINDT	EQUIVALENCE-RATIO AIR-MET.	EQUIVALENCE-RATIO EMISSIONS
-503.84	.0	.0000	.0000	.0000	.00	21.28	.00	.00	59.51	.00	7.83	.000	.822
-460.22	.0	.0000	.0000	.0000	.00	25.28	.00	.00	70.45	.00	8.02	.000	.802
-357.95	.0	.0000	.0000	.0000	.00	28.40	.00	.00	79.14	.00	7.14	.000	.901
-259.44	.0	.0000	.0000	.0000	.00	35.24	.00	.00	98.18	.00	7.22	.000	.892
-172.21	.0	.0000	.0000	.0000	.00	47.09	.00	.00	128.97	.00	7.72	.000	.835
-127.84	.0	.0000	.0000	.0000	.00	52.41	.00	.00	144.02	.00	7.27	.000	.885
-90.24	.0	.0000	.0000	.0000	.00	56.99	.00	.00	155.55	.00	6.90	.000	.933
-70.45	.0	.0000	.0000	.0000	.00	58.59	.00	.00	161.57	.00	6.20	.000	1.039
-45.12	.0	.0000	.0000	.0000	.00	64.30	.00	.00	177.32	.00	5.61	.000	1.140
-26.32	.0	.0000	.0000	.0000	.00	70.04	.00	.00	193.13	.00	5.32	.000	1.209
-4.51	.0	.0000	.0000	.0000	.00	75.58	.00	.00	208.41	.00	4.96	.000	1.298

HC-PPM WET	HC-PPM DRY	H C G/H	NOX-PPM WET	NOX-PPM DRY	NOX-PPM DRY.COR.	NOX G/H	CO-PPM WET	CO-PPM DRY	C O G/H	CO2-(%) WET	CO2-(%) DRY	CO2 G/H	O 2 %
872.7	1080.0	23.62	220.0	272.2	212.4	13.35	1414.2	1750.0	66.95	9.54	11.80	7093.2	4.20
1242.5	1530.0	39.54	125.0	153.9	120.1	8.92	1340.0	1650.0	74.58	9.34	11.50	8167.7	4.70
1094.3	1380.0	40.00	170.0	214.4	167.3	13.93	1252.9	1580.0	80.10	10.31	13.00	10355.0	2.50
1193.3	1500.0	54.19	200.0	251.4	196.1	20.36	1193.3	1500.0	94.79	10.18	12.80	12709.3	2.70
1402.3	1740.0	82.23	160.0	198.5	154.9	21.03	1047.7	1300.0	107.47	9.67	12.00	15586.3	4.00
947.3	1200.0	60.98	290.0	367.4	286.6	41.85	1089.4	1380.0	122.66	10.50	13.30	18574.7	2.90
630.3	810.0	43.94	490.0	629.7	491.3	76.57	1284.0	1650.0	156.57	11.05	14.20	21171.2	1.80
803.6	1050.0	59.88	540.0	705.6	550.5	90.20	9949.4	13000.0	1296.84	11.10	14.50	22727.4	.30
1104.6	1440.0	94.56	210.0	273.8	213.6	40.30	29915.4	39000.0	4479.49	9.74	12.70	22919.5	.30
1192.1	1560.0	112.14	200.0	261.7	204.2	42.17	39736.5	52000.0	6538.48	9.32	12.20	24103.6	.20
2087.1	2700.0	224.53	110.0	142.3	111.0	26.53	50244.4	65000.0	9454.61	8.35	10.80	24682.7	.20

PARTICULATES G/H	PARTICULATES G/KW.H	H C G/KW.H	NOX G/KW.H	C O G/KW.H	CO2 G/KW.H	START INJ.	END INJ.	START COMB.	IGNITION TIMING	EXHAUST TEMP.C	BRAKE THERM.EFF	E.G.R. (%)	BOOST PRESS. RATIO
.00	.000	10.272	5.804	29.114	3084.50	.0	.0	.0	24.0	396.0	7.85	.51	.340
.00	.000	9.282	2.093	17.508	1917.30	.0	.0	.0	24.0	414.0	12.59	6.09	.397
.00	.000	4.553	1.586	9.119	1178.87	.0	.0	.0	24.0	436.0	20.58	13.92	.531
.00	.000	4.155	1.561	7.267	974.35	.0	.0	.0	23.5	460.0	24.88	14.61	.660
.00	.000	4.681	1.197	6.117	887.21	.0	.0	.0	13.4	475.0	27.27	9.83	.774
.00	.000	2.760	1.894	5.552	840.80	.0	.0	.0	11.2	512.0	28.94	8.35	.833
.00	.000	1.682	2.931	5.993	810.37	.0	.0	.0	10.2	564.0	30.09	7.32	.882

.00	.000	1.942	2.925	42.054	737.00	.0	.0	.0	10.0	559.0	30.69	5.93	.903
.00	.000	2.683	1.143	127.083	650.22	.0	.0	.0	10.0	565.0	28.94	2.99	.941
.00	.000	2.877	1.082	167.736	618.33	.0	.0	.0	10.0	563.0	27.88	.00	.966
.00	.000	5.303	.627	223.323	583.02	.0	.0	.0	10.0	561.0	26.16	.00	.994

EPA/VW BRCC METHANOL (79.5mm X 73.4mm)

M.E.C./BOSCH IGNITION - CORRECT INJECTORS

MAPPING AT 80 REV/SEC WITH AUTO E.G.R.

REFER TO FIGURE NOS. 110-116

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.40	4	4.	159.1551	.000000	.7950	3.97	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
2	3	86	80.00	767.00	8.50	16.00	0	0.	1

1	ENGINE SPEED (REV/S)	80.00	80.00	80.00	80.00	80.00	80.00
28	IGNITION TIMING	25.00	25.00	25.00	25.00	22.90	22.40
4	FUEL VOLUME (CC)	102.50	203.00	203.00	203.00	304.00	507.00
2	BRAKE LOAD	13.00	23.50	34.90	47.10	69.00	81.90
5	FUEL TIME (SEC)	31.80	51.30	42.60	36.00	41.90	60.50
6	FUEL TEMPERATURE (C)	8.00	9.00	9.00	9.00	11.00	11.00
8	AIR METER TEMPERATURE (C)	13.00	14.00	14.00	14.00	19.00	20.00
11	INTAKE MANIFOLD PRESS.(mm.Hg)	-460.98	-400.06	-333.89	-268.46	-166.94	-148.90
26	EXHAUST TEMP. (POST TURBO)	462.0	505.0	526.0	546.0	598.0	638.0
27	EXHAUST PRESSURE (POST TURBO)	27.1	39.9	54.1	72.2	106.0	122.6
13	CARBON MONOXIDE (%)	.168	.152	.145	.138	.124	.700
15	CARBON DIOXIDE (%)	11.500	11.500	11.500	11.500	12.400	14.000
16	OXYGEN (%)	4.700	4.800	4.800	4.800	3.600	1.000
12	HYDROCARBONS (PPMC)	960.0	840.0	840.0	750.0	420.0	480.0
14	OXIDES OF NITROGEN (PPM)	-460.0	-660.0	-820.0	-1100.0	-1900.0	-2600.0
17	INTAKE MANIFOLD CO2 (%)	.000	.000	.000	.000	.000	.000
30	AMBIENT CO2 (%)	.000	.000	.000	.000	.000	.000

EPA/VW HRCC METHANOL (79.5mm x 73.4mm)
N.E.C./BOSCH IGNITION - CORRECT INJECTORS
MAPPING AT 80 REV/SEC WITH AUTO E.G.R.

REFER TO FIGURE NOS. 110-116

DATE 27 3/86 TEST NO. 80.0 BAROMETER 767.00 MM.HG WET BULB TEMP(C) 8.5 DRY BULB TEMP(C) 16.0
RELATIVE HUMIDITY = 32.93
HUMIDITY CORRECTION FACTOR = .78 GRAINS OF WATER/LB DRY AIR = 25.62

SPEED	POWER-(KW)		BMEP-(bar)		TORQUE-(NM)		FUEL-CONSUMPTION			BSFC	BOSCH	CELESCO	CORRECTED
REV/S	UN.CORR	CORR	UN.CORR	CORR	UN.CORR	CORR	G/HR	MM3/INJ	MG/LITRE	G/KW.H	SMOKE	SMOKE	AIR FLOW(SEAT)
80.00	6.53	6.53	1.12	1.12	13.00	13.00	9284.	20.15	44.23	1420.8	.0	.0	.0000
80.00	11.81	11.81	2.03	2.03	23.50	23.50	11387.	24.73	54.25	964.0	.0	.0	.0000
80.00	17.54	17.54	3.01	3.01	34.90	34.90	13713.	29.78	65.33	761.7	.0	.0	.0000
80.00	23.68	23.68	4.06	4.06	47.10	47.10	16227.	35.24	77.31	685.4	.0	.0	.0000
80.00	34.68	34.68	5.95	5.95	69.00	69.00	20841.	45.35	99.29	600.9	.0	.0	.0000
80.00	41.17	41.17	7.06	7.06	81.90	81.90	24072.	52.38	114.68	584.7	.0	.0	.0000

MAN.PRES	MAN.TEMP	INTAKE-AIR-(M3/S)		AIR-MASS	FREE-AIR-VOL.EFF.		VOL.EFF.	MANIFOLD-VOL.EFF.		AIR/FUEL-RATIO		EQUIVALENCE-RATIO	
MM.HG	C	FREE	AFT.MET	KG/S	AIR-MET.	SPINDT	AFT.MET	AIR-MET.	SPINDT	AIR-MET.	SPINDT	AIR-MET.	EMISSIONS
-460.98	.0	.0000	.0000	.0000	.00	28.64	.00	.00	68.52	.00	8.07	.000	.798
-400.06	.0	.0000	.0000	.0000	.00	35.49	.00	.00	84.60	.00	8.1	.000	.793
-333.89	.0	.0000	.0000	.0000	.00	42.76	.00	.00	101.94	.00	8.12	.000	.793
-268.46	.0	.0000	.0000	.0000	.00	50.67	.00	.00	120.60	.00	8.1[illegible]	.000	.791
-166.94	.0	.0000	.0000	.0000	.00	62.14	.00	.00	145.62	.00	7.6[illegible]	.000	.843
-148.90	.0	.0000	.0000	.0000	.00	61.92	.00	.00	144.61	.00	6.56	.000	.981

HC-PPM	HC-PPM	HC	NOX-PPM	NOX-PPM	NOX-PPM	NOX	CO-PPM	CO-PPM	CO	CO2-(%)	CO2-(%)	CO2	O2
WET	DRY	G/H	WET	DRY	DRY.COR.	G/H	WET	DRY	G/H	WET	DRY	G/H	%
779.6	960.0	37.88	460.0	566.4	440.0	49.88	1364.5	1680.0	115.95	9.34	11.50	12470.7	4.70
682.3	840.0	40.75	660.0	812.6	631.2	67.98	1234.6	1520.0	128.98	9.34	11.50	15332.5	4.80
682.3	840.0	49.10	820.0	1009.5	784.2	131.70	1177.8	1450.0	146.26	9.34	11.50	18474.6	4.80
609.3	750.0	51.95	1100.0	1354.1	1051.9	209.33	1121.1	1380.0	167.20	9.34	11.50	21891.6	4.80
336.4	420.0	34.83	1900.0	2372.5	1842.9	439.08	993.1	1240.0	179.85	9.93	12.40	26256.6	3.60
372.5	480.0	39.17	2600.0	3350.0	2602.3	610.17	5432.8	7000.0	999.19	10.87	14.00	31399.0	1.00

PARTICULATES		HC	NOX	CO	CO2	START	END	START	IGNITION	EXHAUST	BRAKE	E.G.R.	BOOST PRESS.
G/H	G/KW.H	G/KW.H	G/KW.H	G/KW.H	G/KW.H	INJ.	INJ.	COMB.	TIMING	TEMP.C	THERM.EFF	(%)	RATIO
.00	.000	5.797	7.634	17.744	1908.44	.0	.0	.0	25.0	462.0	12.71	.00	.399
.00	.000	3.450	7.448	10.919	1298.01	.0	.0	.0	25.0	505.0	18.73	.00	.478
.00	.000	2.799	7.508	8.451	1053.14	.0	.0	.0	25.0	526.0	23.10	.00	.565
.00	.000	2.194	8.842	7.062	924.68	.0	.0	.0	25.0	546.0	26.34	.00	.650
.00	.000	1.004	12.660	5.186	814.77	.0	.0	.0	22.9	598.0	30.05	.00	.782
.00	.000	.952	14.822	24.271	762.72	.0	.0	.0	22.4	638.0	30.88	.00	.806

EPA 1.5L HRCC VW ENGINE

13:1 CR

REFER TO FIGURE NOS. 51-54

FULL LOAD POWER CURVE

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.00	4	4.	9.0640	.000000	.8180	4.00	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
16	8	82	94.00	762.10	17.00	23.00	1	1.	4

1 ENGINE SPEED (REV/S)	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00
2 BRAKE LOAD	5.25	6.10	6.56	6.65	6.50	6.42	6.15	5.55
3 FUEL MASS (GRAMS)	150.00	200.00	250.00	250.00	250.00	250.00	250.00	250.00
5 FUEL TIME (SEC)	65.00	54.70	52.96	38.20	32.60	28.00	25.40	23.20
6 FUEL TEMPERATURE (C)	22.00	22.00	22.00	23.00	25.00	23.00	23.00	25.00
8 AIR METER TEMPERATURE (C)	26.00	26.00	26.00	25.00	30.00	31.00	34.00	35.00
12 HYDROCARBONS (PPMC)	-1710.0	-2280.0	-1680.0	-1465.0	-1410.0	-4950.0	-1890.0	-1980.0
13 CARBON MONOXIDE (%)	5.000	4.400	3.700	5.600	5.640	5.700	5.400	5.500
14 OXIDES OF NITROGEN (PPM)	-1820.0	-1890.0	-1430.0	-840.0	-780.0	-930.0	-1000.0	-1000.0
15 CARBON DIOXIDE (%)	11.400	12.100	12.600	12.300	11.200	11.300	11.500	11.500
16 OXYGEN (%)	.900	.700	.600	.500	.450	.450	.500	.500
28 IGNITION TIMING	9.00	12.00	15.00	18.00	20.00	23.00	24.00	25.00
26 EXHAUST TEMP. (POST TURBO)	397.0	477.0	547.0	564.0	591.0	620.0	639.0	650.0
11 INTAKE MANIFOLD PRESS.(mm.Hg)	.00	.00	.00	.00	.00	.00	.00	.00

EPA 1.5L HRCC VW ENGINE

13:1 CR

FULL LOAD POWER CURVE

REFER TO FIGURE NOS. 51-54

DATE 16/ 8/82   TEST NO. 94.0   BAROMETER 762.10 MM.HG   WET BULB TEMP(C) 17.0
DRY BULB TEMP(C) 23.0

RELATIVE HUMIDITY = 54.51
HUMIDITY CORRECTION FACTOR = 1.26
GRAINS OF WATER/LB DRY AIR = 66.55

: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :

RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

POWERS CORRECTED TO DIN.70020

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
20.0	11.67	8.05	92.87	717.2	74.0(.0)	5.5(.0)	25.17	4.78	13.73	188.67	675.86	18.51
30.0	20.34	9.35	107.91	651.9	79.4(.0)	5.6(.0)	27.69	5.77	12.91	149.36	645.35	18.68
40.0	29.16	10.06	116.04	587.0	79.0(.0)	5.7(.0)	30.76	3.90	8.97	114.99	615.26	12.86
50.0	36.89	10.18	117.44	642.3	81.5(.0)	5.4(.0)	28.11	3.48	5.16	173.82	599.86	8.64
60.0	43.63	10.03	115.75	641.6	79.4(.0)	5.3(.0)	28.14	3.45	5.80	185.91	560.06	9.25
70.0	50.36	9.93	114.51	646.3	77.9(.0)	5.2(.0)	27.85	11.84	7.00	183.17	570.55	18.84
80.0	55.41	9.56	110.24	652.8	78.4(.0)	5.3(.0)	27.66	4.69	8.62	179.80	601.62	13.30
90.0	56.34	8.64	99.64	703.9	76.3(.0)	5.3(.0)	25.65	5.26	9.60	196.20	644.58	14.87

40REV/S 2.5BAR

MIXTURE LOOP

REFER TO FIGURE NOS. 55-58

BN60Y

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.00	4	4.	9.0640	.000281	.8160	4.00	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
8	9	82	38.00	767.80	17.50	21.20	0	1.	4

1 ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00	40.00	40.00
2 BRAKE LOAD	1.64	1.64	1.64	1.64	1.64	1.64
3 FUEL MASS (GRAMS)	100.00	100.00	100.00	100.00	100.00	100.00
5 FUEL TIME (SEC)	54.40	59.60	60.20	61.30	62.60	61.20
6 FUEL TEMPERATURE (C)	26.00	26.00	26.00	26.00	26.00	26.00
7 AIR METER READING	34.00	36.00	37.20	40.30	44.10	53.60
9 AIR METER DEPRESSION (mm.Hg)	1.20	1.27	1.32	1.46	1.58	1.93
8 AIR METER TEMPERATURE (C)	24.00	24.00	25.00	25.00	25.00	24.00
12 HYDROCARBONS (PPMC)	-1200.0	-900.0	-1050.0	-1380.0	-1800.0	-3300.0
13 CARBON MONOXIDE (%)	1.600	.140	.140	.130	.120	.190
14 OXIDES OF NITROGEN (PPM)	-530.0	-730.0	-780.0	-370.0	-135.0	-18.0
15 CARBON DIOXIDE (%)	13.800	13.400	12.700	11.300	10.100	7.800
16 OXYGEN (%)	.350	2.000	3.100	5.000	7.100	9.900
28 IGNITION TIMING	17.00	21.00	23.00	25.00	30.00	39.00
26 EXHAUST TEMP. (POST TURBO)	438.0	442.0	437.0	422.0	413.0	393.0
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-435.00	-420.00	-412.50	-393.75	-363.75	-300.00

40REV/S 2.5BAR

MIXTURE LOOP

BN60Y

REFER TO FIGURE NOS. 55-58

DATE 8/ 9/82   TEST NO. 38.0   BAROMETER 767.80 MM.HG   WET BULB TEMP(C) 17.5
DRY BULB TEMP(C) 21.2

RELATIVE HUMIDITY = 69.41
HUMIDITY CORRECTION FACTOR = .95
GRAINS OF WATER/LB DRY AIR = 75.54

: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :

RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	7.24	2.50	28.60	914.4	32.5(32.6)	6.2(6.2)	19.75	4.59	5.12	82.25	1114.59	9.72
40.0	7.24	2.50	28.80	834.6	33.9(34.5)	7.0(7.2)	21.63	3.51	7.35	7.48	1125.43	10.85
40.0	7.24	2.50	28.80	826.3	35.6(35.5)	7.4(7.4)	21.85	4.22	8.28	7.80	1111.56	12.49
40.0	7.24	2.50	28.80	811.4	38.7(38.5)	8.2(8.2)	22.25	5.95	4.26	7.95	1066.19	10.21
40.0	7.24	2.50	28.80	794.6	42.7(42.1)	9.3(9.1)	22.72	8.28	1.68	7.99	1056.59	9.96
40.0	7.24	2.50	28.80	812.8	52.9(51.3)	11.3(10.9)	22.21	18.63	.28	16.13	1040.39	18.90

40REV/S 5.5BAR

MIXTURE LOOP

BN60Y

REFER TO FIGURE NOS. 59-62

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.00	4	4.	9.0640	.000281	.8180	4.00	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
10	9	82	40.00	767.30	20.20	24.80	0	1.	4

1 ENGINE SPEED (REV/S)	40.00	40.00	40.00	40.00	40.00	40.00
2 BRAKE LOAD	3.60	3.60	3.60	3.60	3.60	3.60
3 FUEL MASS (GRAMS)	150.00	150.00	150.00	150.00	150.00	150.00
5 FUEL TIME (SEC)	53.68	56.70	57.80	59.40	60.40	59.90
6 FUEL TEMPERATURE (C)	26.00	26.00	26.00	28.00	28.00	28.00
7 AIR METER READING	55.00	57.70	60.40	65.50	71.00	81.90
9 AIR METER DEPRESSION (mm.Hg)	1.97	2.08	2.19	2.37	2.57	2.99
8 AIR METER TEMPERATURE (C)	29.00	28.00	28.00	26.00	27.00	27.00
12 HYDROCARBONS (PPMC)	-1020.0	-900.0	-990.0	-1275.0	-1560.0	-2190.0
13 CARBON MONOXIDE (%)	1.500	.200	.100	.110	.110	.130
14 OXIDES OF NITROGEN (PPM)	-820.0	-1220.0	-1150.0	-780.0	-290.0	-78.0
15 CARBON DIOXIDE (%)	13.900	13.600	12.800	11.400	9.700	8.400
16 OXYGEN (%)	.400	1.900	3.200	5.000	6.900	9.000
28 IGNITION TIMING	17.00	22.00	24.00	27.00	29.00	34.00
26 EXHAUST TEMP. (POST TURBO)	508.0	509.0	496.0	477.0	462.0	440.0
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-270.00	-247.50	-232.50	-196.75	-157.50	-82.50

40REV/S 5.5BAR

MIXTURE LOOP

P460Y

REFER TO FIGURE NOS. 59-62

DATE 10/ 9/82 TEST NO. 40.0 BAROMETER 767.30 MM.HG WET BULB TEMP(C) 20.2
DRY BULB TEMP(C) 24.8

RELATIVE HUMIDITY = 65.61
HUMIDITY CORRECTION FACTOR = .97
GRAINS OF WATER/LB DRY AIR = 89.09

::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
40.0	15.89	5.48	63.21	633.2	50.7(51.9)	6.2(6.4)	28.51	2.71	5.92	53.48	778.61	8.63
40.0	15.89	5.48	63.21	599.5	53.8(54.6)	7.0(7.1)	30.12	2.48	9.06	7.54	805.09	11.54
40.0	15.89	5.48	63.21	588.1	56.5(57.2)	7.5(7.6)	30.70	2.82	8.90	3.95	794.11	11.72
40.0	15.89	5.48	63.21	572.2	60.6(62.0)	8.2(8.4)	31.55	3.86	6.49	4.72	768.29	10.35
40.0	15.89	5.48	63.21	562.7	67.3(67.5)	9.3(9.3)	32.08	5.27	2.69	5.42	750.31	7.96
40.0	15.89	5.48	63.21	567.4	77.8(77.6)	10.7(10.7)	31.82	8.31	.82	7.34	745.41	9.13

MIX LOOP

IGN LOOP

REFER TO FIGURE NOS. 63-66 and 67-70

BN60Y

BORE	STROKE	NUMBER OF CYLINDERS	CYCLE TYPE	BRAKE CONSTANT	AIR METER CONSTANT	FUEL S.G.	H/CARBON RATIO	CALORIFIC VALUE	TURBOCHARGED OPTION
79.50	73.00	4	4.	9.0640	.000000	.8180	4.00	19940.00	0

DAY	MONTH	YEAR	TEST NUMBER	BAROMETER	WET BULB TEMPERATURE	DRY BULB TEMPERATURE	POWER CORRECTION	FRICTION OPTION	OUTPUT OPTION
15	1	83	98.00	761.70	14.00	20.00	0	1.	4

1 ENGINE SPEED (REV/S)	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
2 BRAKE LOAD	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
3 FUEL MASS (GRAMS)	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
5 FUEL TIME (SEC)	56.90	68.70	69.00	59.20	65.40	72.20	69.50	66.00	74.80	70.80	70.00	71.50
6 FUEL TEMPERATURE (C)	16.00	17.00	17.00	17.00	17.00	19.00	19.00	18.00	19.00	19.00	19.00	19.00
8 AIR METER TEMPERATURE (C)	34.00	29.00	27.00	25.00	24.00	33.00	32.00	33.00	33.00	33.00	32.00	33.00
12 HYDROCARBONS (PPMC)	-6150.0	-3150.0	-4500.0	-4200.0	-3150.0	-3000.0	-2850.0	-2280.0	-3450.0	-3300.0	-4500.0	-3180.0
13 CARBON MONOXIDE (%)	6.000	1.600	.800	4.800	2.800	1.800	1.800	1.600	1.600	1.600	1.700	1.600
14 OXIDES OF NITROGEN (PPM)	-7.3	-8.4	-8.8	-7.0	-8.0	-9.0	-8.5	-8.6	-9.0	-9.0	-9.5	-7.5
15 CARBON DIOXIDE (%)	10.500	13.400	13.000	11.300	12.400	13.000	12.900	13.100	12.700	12.600	12.500	12.600
16 OXYGEN (%)	1.500	1.200	2.100	1.100	.900	1.000	1.000	.800	1.300	1.200	1.400	1.100
28 IGNITION TIMING	19.00	19.00	19.00	19.00	19.00	19.00	14.00	9.00	25.00	30.00	35.00	19.00
26 EXHAUST TEMP. (POST TURBO)	137.0	137.0	137.0	137.0	137.0	137.0	153.0	157.0	148.0	140.0	137.0	138.0
11 INTAKE MANIFOLD PRESS.(mm.Hg)	-525.00	-525.00	-525.00	-525.00	-525.00	-532.50	-525.00	-525.00	-532.50	-525.00	-532.50	-525.00

MIX LOOP

IGN LOOP

DN60Y

REFER TO FIGURE NOS. 63-66 and 67-70

DATE 15/ 1/83   TEST NO. 98.0   BAROMETER 761.70 MM.HG   WET BULB TEMP(C) 14.0
DRY BULB TEMP(C) 20.0

RELATIVE HUMIDITY = 51.00
HUMIDITY CORRECTION FACTOR = 1.19
GRAINS OF WATER/LB DRY AIR = 51.68

:::
: IF POWER = 0.0 RESULTS LISTED AS G/KW-HR ARE ACTUALLY G/HR :
:::
RESULTS IN (BRACKETS) ARE CALCULATED FROM AIR METER DATA

SPEED REV/S	POWER KW	BMEP BAR	TORQUE N.M	FUEL G/KW.HR	VOLUMETRIC EFFICIENCY(%)	AIR FUEL RATIO	B.T.E. %	H C G/KW.HR	NOX G/KW.HR	C O G/KW.HR	CO2 G/KW.HR	HC + NOX G/KW.HR
15.0	.00	.00	.00	1265.4	14.8(.0)	5.3(.0)	.00	28.97	.13	384.01	1055.90	29.11
15.0	.00	.00	.00	1048.0	14.4(.0)	6.3(.0)	.00	13.87	.11	95.18	1252.52	13.98
15.0	.00	.00	.00	1043.5	15.2(.0)	6.7(.0)	.00	20.83	.12	50.79	1296.89	20.95
15.0	.00	.00	.00	1216.2	14.4(.0)	5.5(.0)	.00	19.81	.09	306.79	1134.81	19.91
15.0	.00	.00	.00	1100.9	14.0(.0)	5.9(.0)	.00	14.33	.10	172.75	1202.04	14.43
15.0	.00	.00	.00	997.2	13.7(.0)	6.2(.0)	.00	12.69	.13	103.37	1173.05	12.83
15.0	.00	.00	.00	1036.0	14.2(.0)	6.2(.0)	.00	12.61	.13	108.24	1218.87	12.73
15.0	.00	.00	.00	1090.9	15.0(.0)	6.2(.0)	.00	10.68	.14	101.81	1309.74	10.82
15.0	.00	.00	.00	962.6	13.4(.0)	6.3(.0)	.00	14.42	.13	91.37	1139.55	14.55
15.0	.00	.00	.00	1016.9	14.1(.0)	6.3(.0)	.00	14.67	.14	97.32	1204.24	14.80
15.0	.00	.00	.00	1028.6	14.2(.0)	6.3(.0)	.00	20.01	.14	103.51	1195.84	20.15
15.0	.00	.00	.00	1007.0	14.0(.0)	6.3(.0)	.00	14.01	.11	96.47	1193.70	14.12

C.R.M. /L.M.

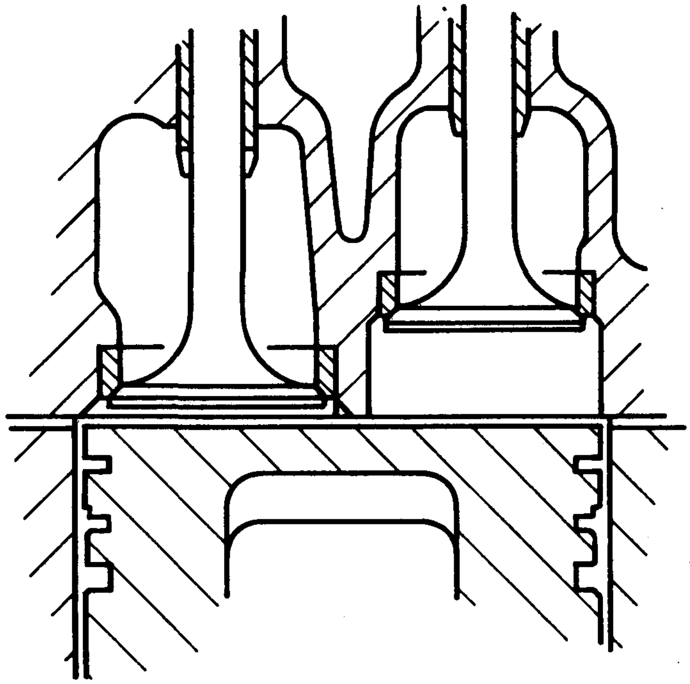
RICARDO

FIG. No. 1

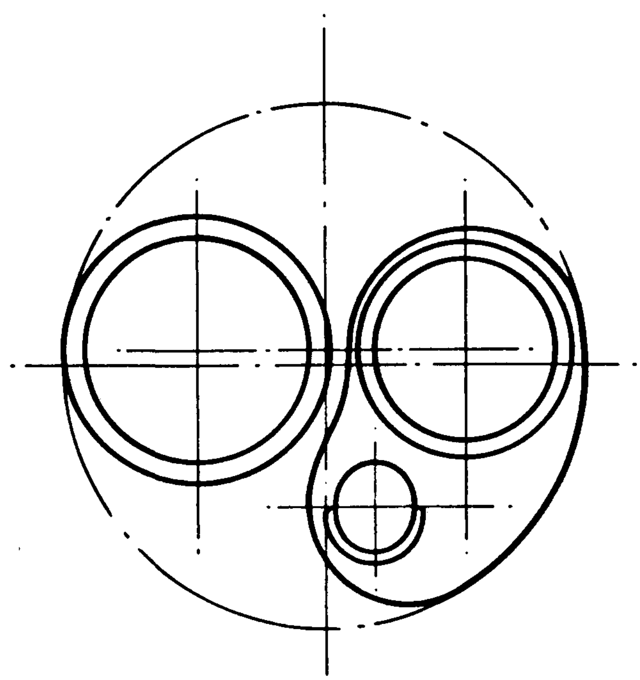
Drg. No. S. 5803

Date MARCH '83

RICARDO MULTI-CYLINDER HRCC



Transverse Section



View on Cylinder Head Face

RICARDO

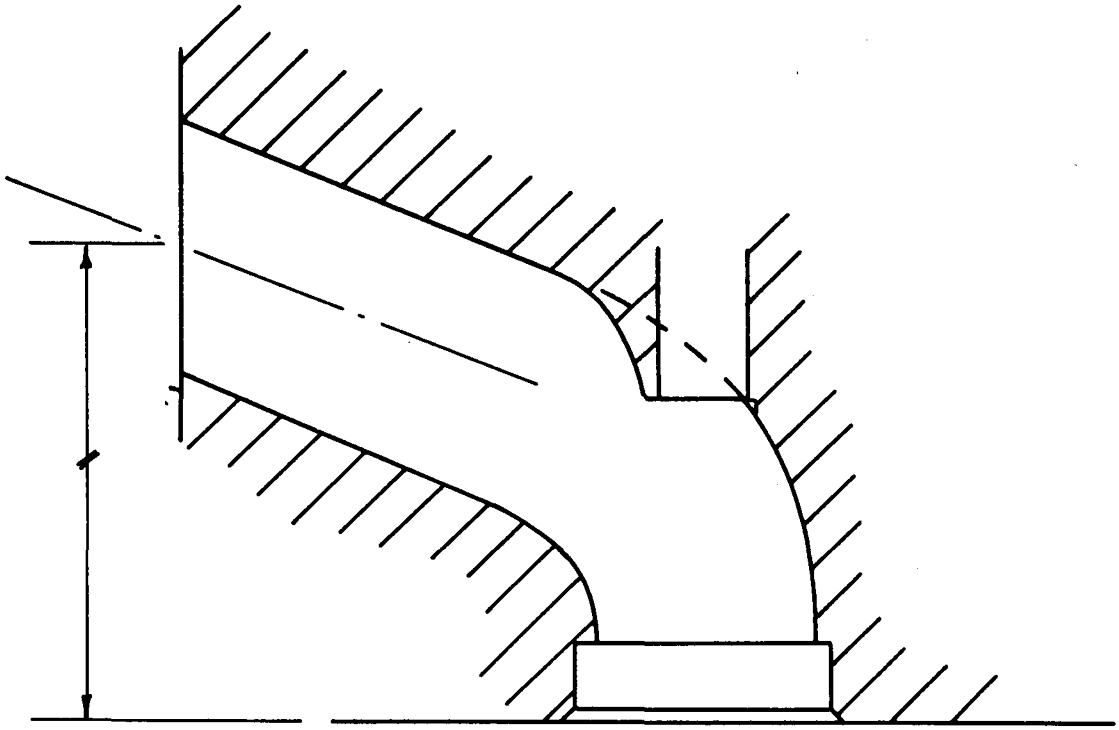
FIG. No. 2

Drg. No. S. 7223

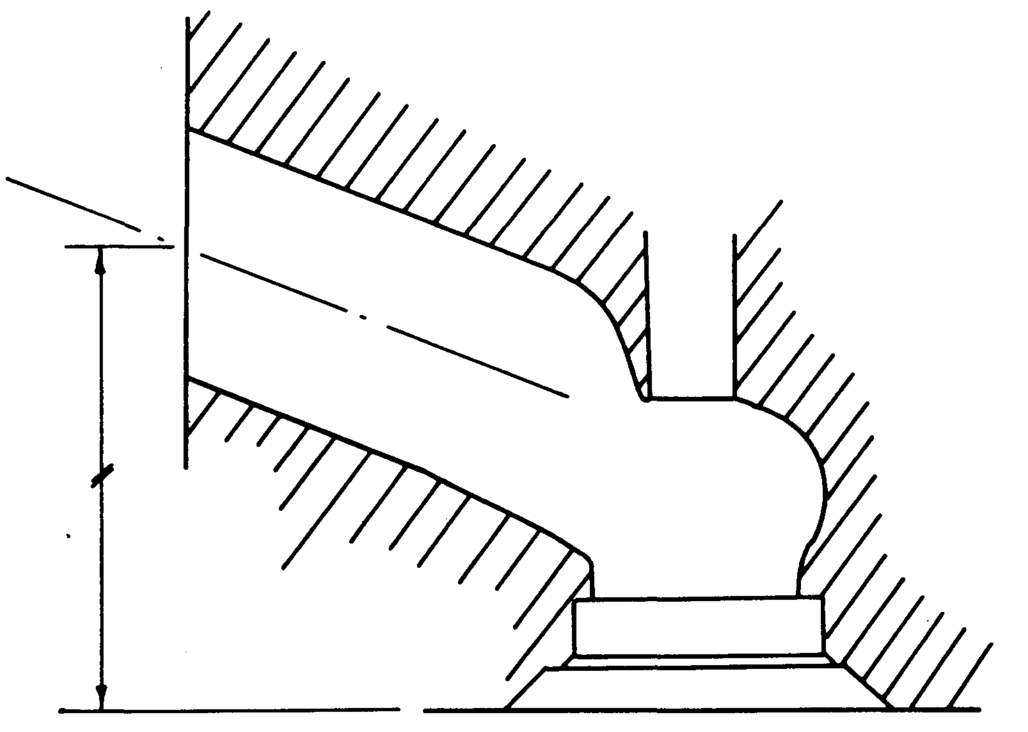
Date MAY '82

RICARDO MULTICYLINDER HRCC

INLET PORT DESIGN



HRCC



I.GL. BASELINE

RICARDO CONSULTING ENGINEERS

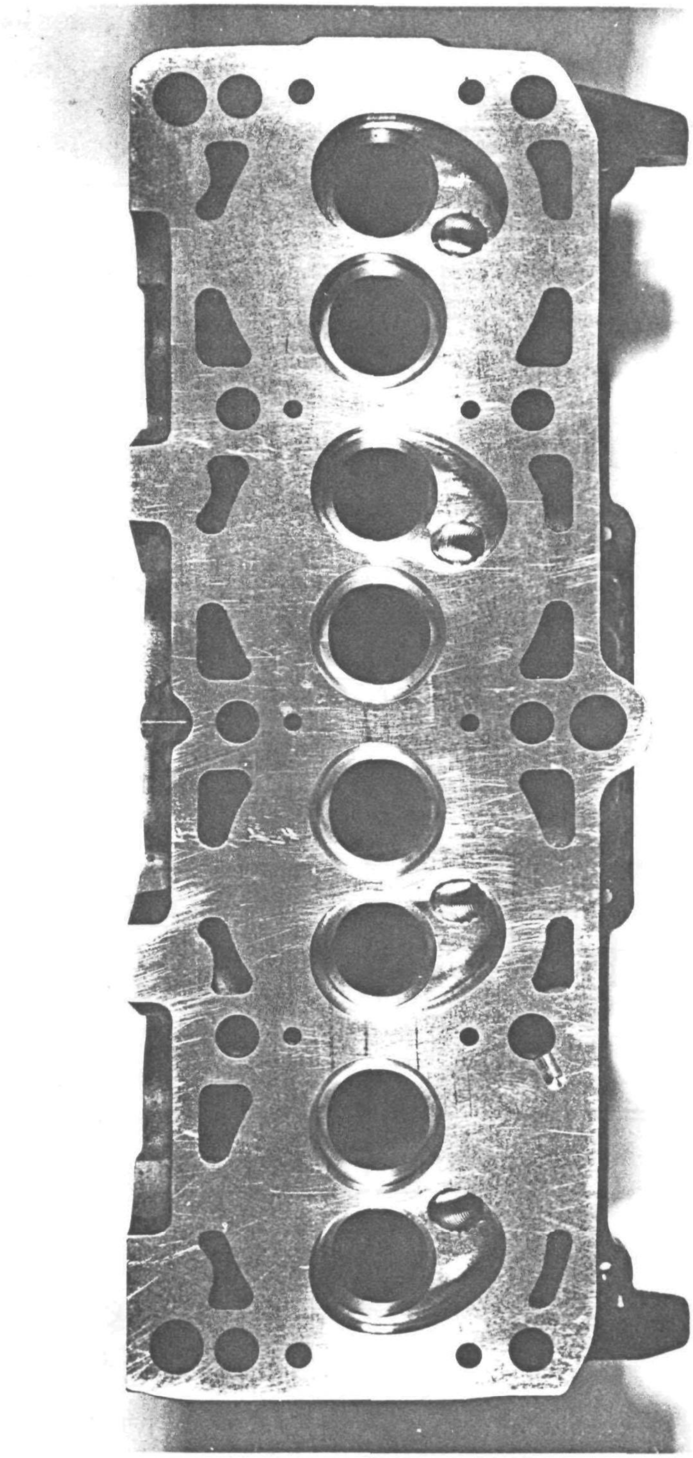
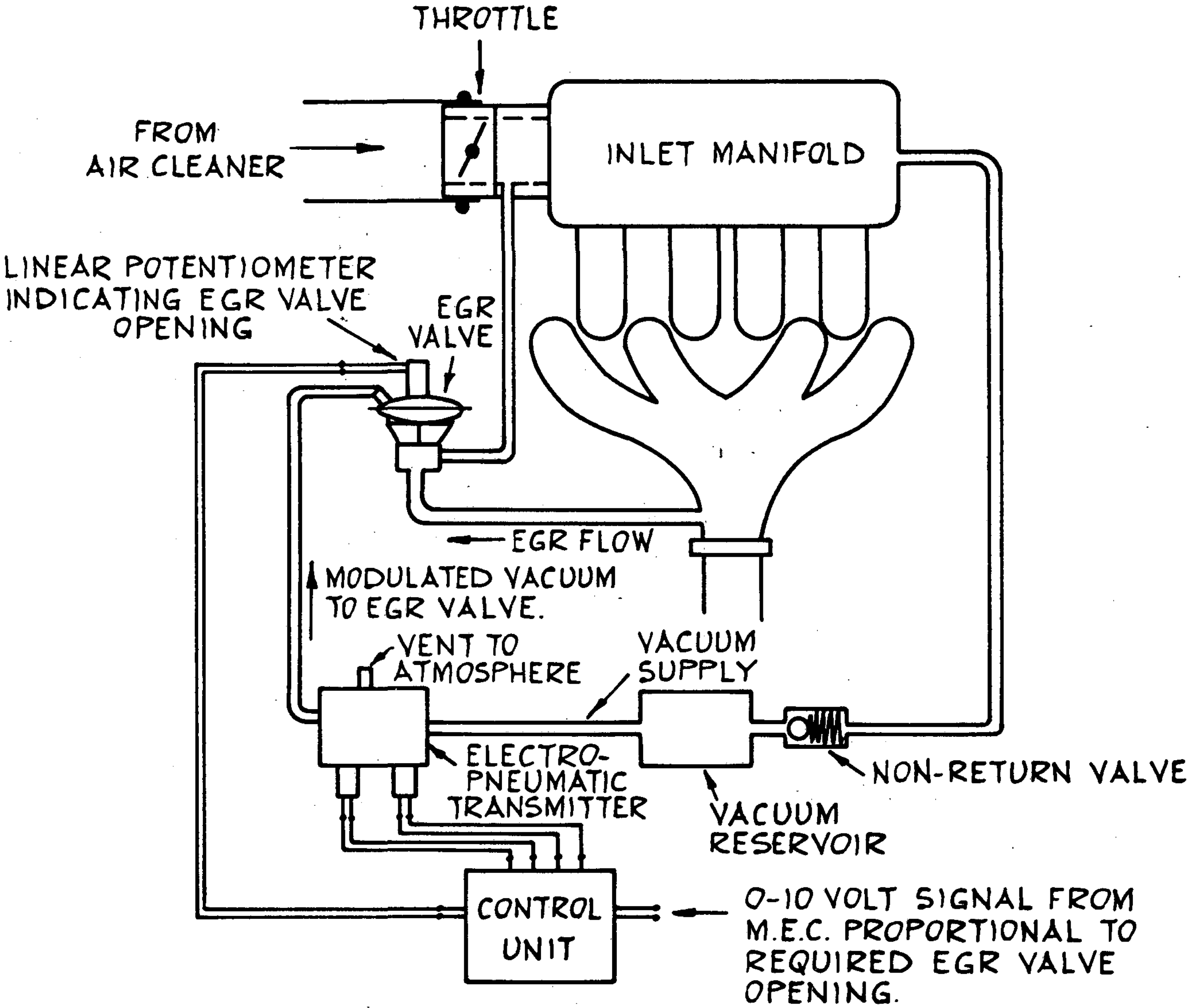


FIG. 3 HRCC CYLINDER HEAD

RICARDO

FIG. No. 4
Drg. No. S. 11173
Date MARCH '85

EGR SYSTEM

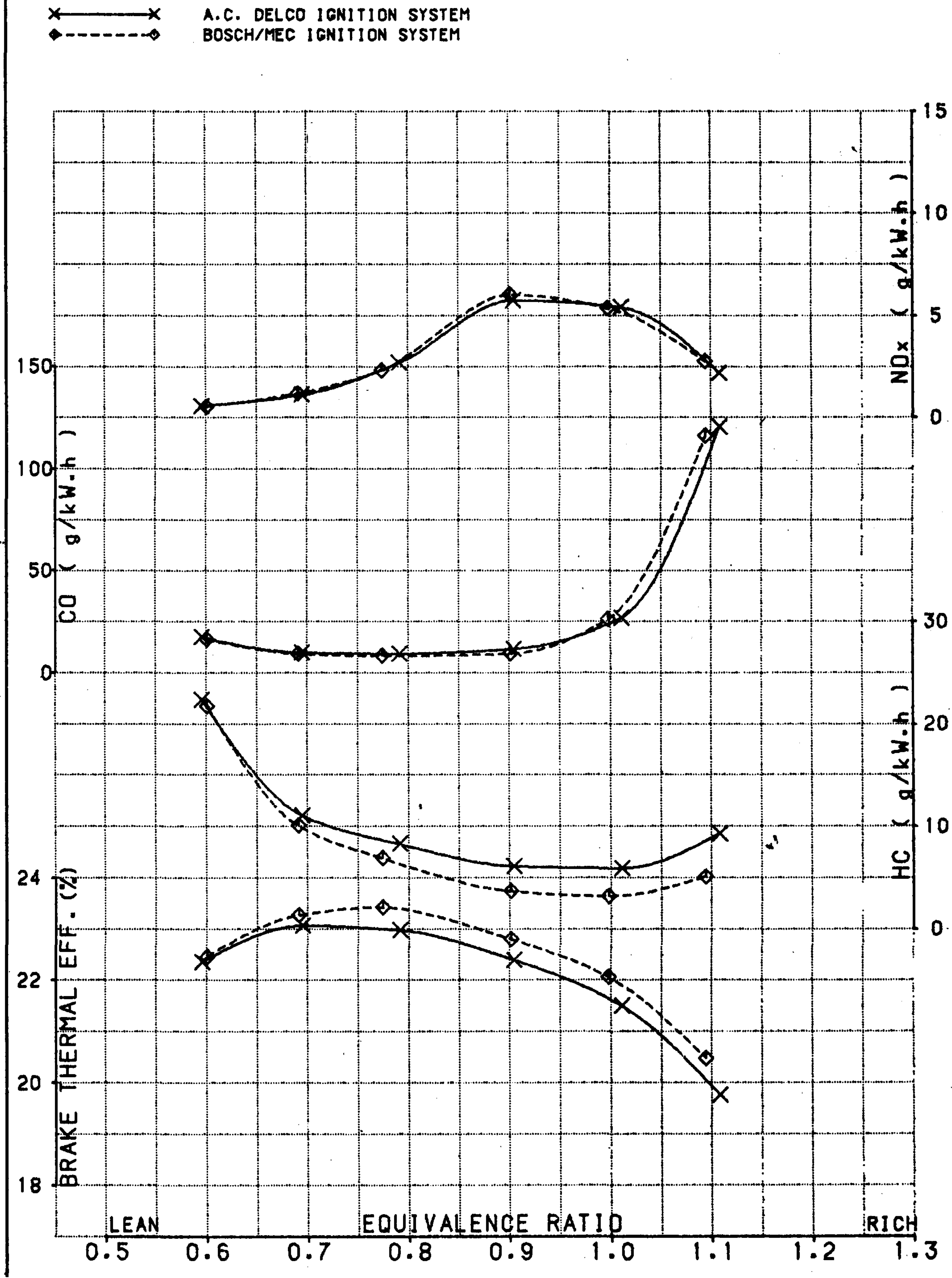


	PIERBURG PART N^os.^ :-
EGR VALVE	T4KR 7.114
ELECTRO-PNEUMATIC TRANSMITTER	7.21.031.00
CONTROL UNIT	PV 12.300

RICARDO

Fig. No. 5
Drg. No.
Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN A.C. DELCO AND BOSCH/MEC IGNITION SYSTEMS
MIXTURE LOOPS AT 40 REV/SEC 2.5 BAR BMEP



RICARDO

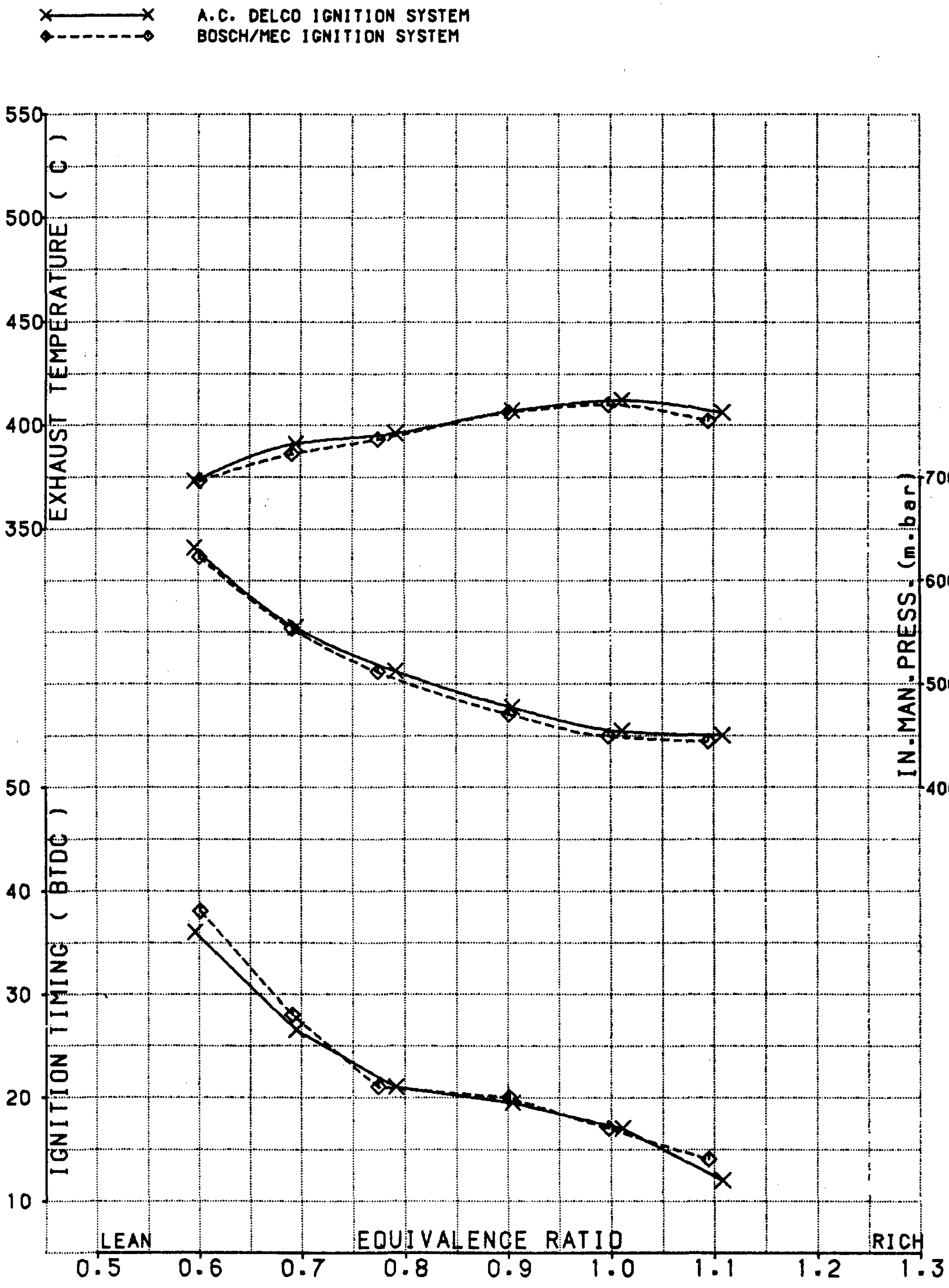
Fig. No. 6

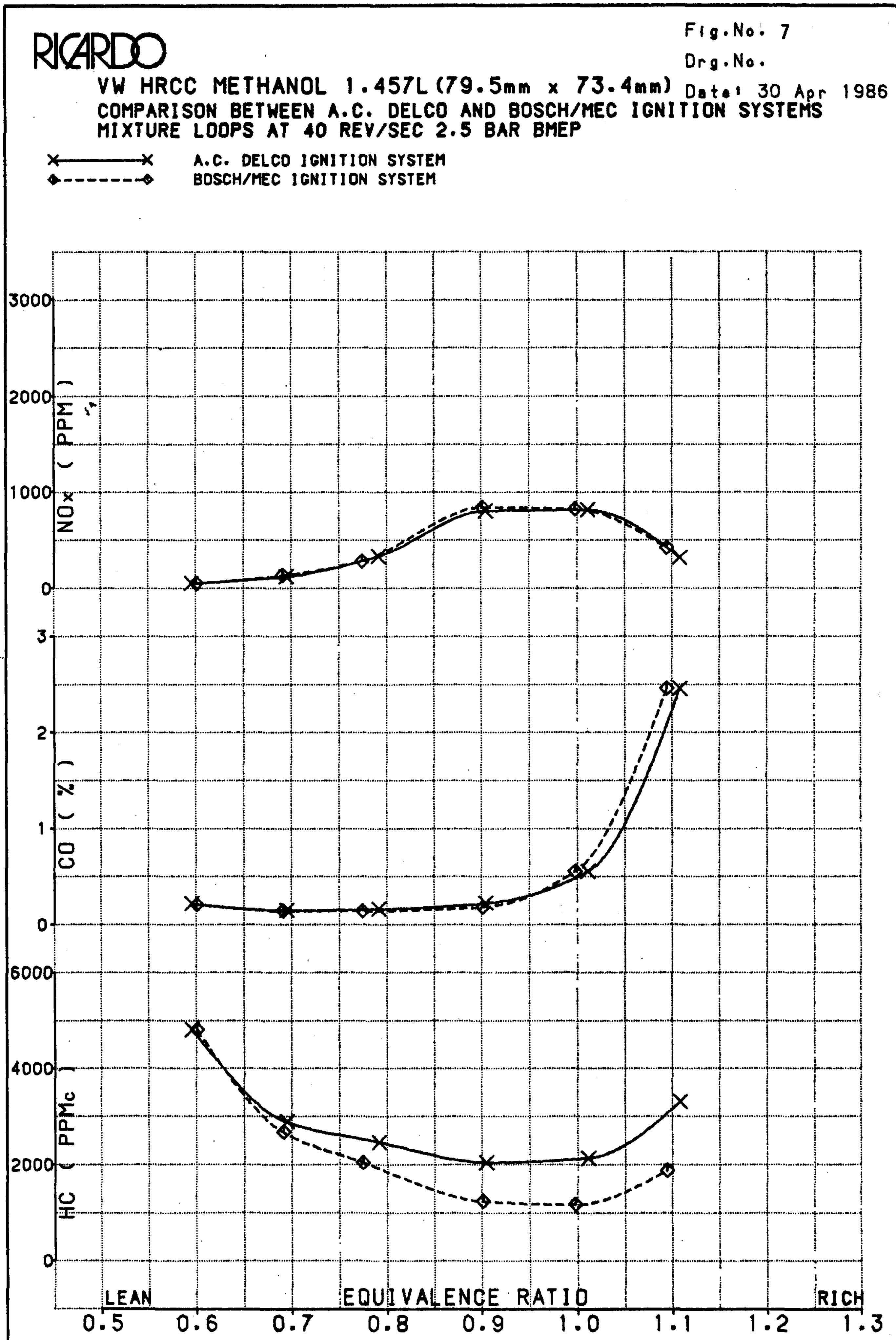
Drg. No.

Date: 30 Apr 1986

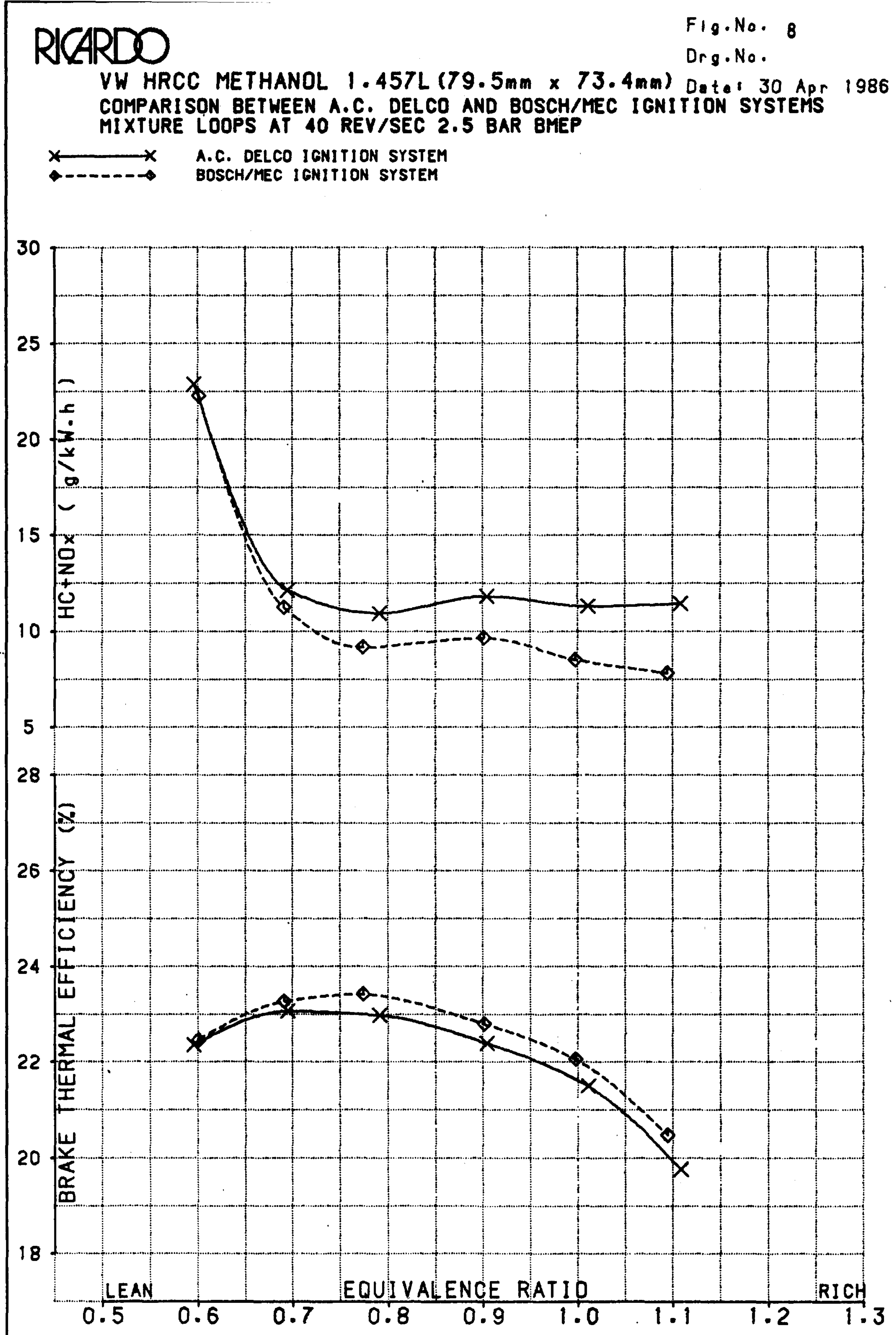
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

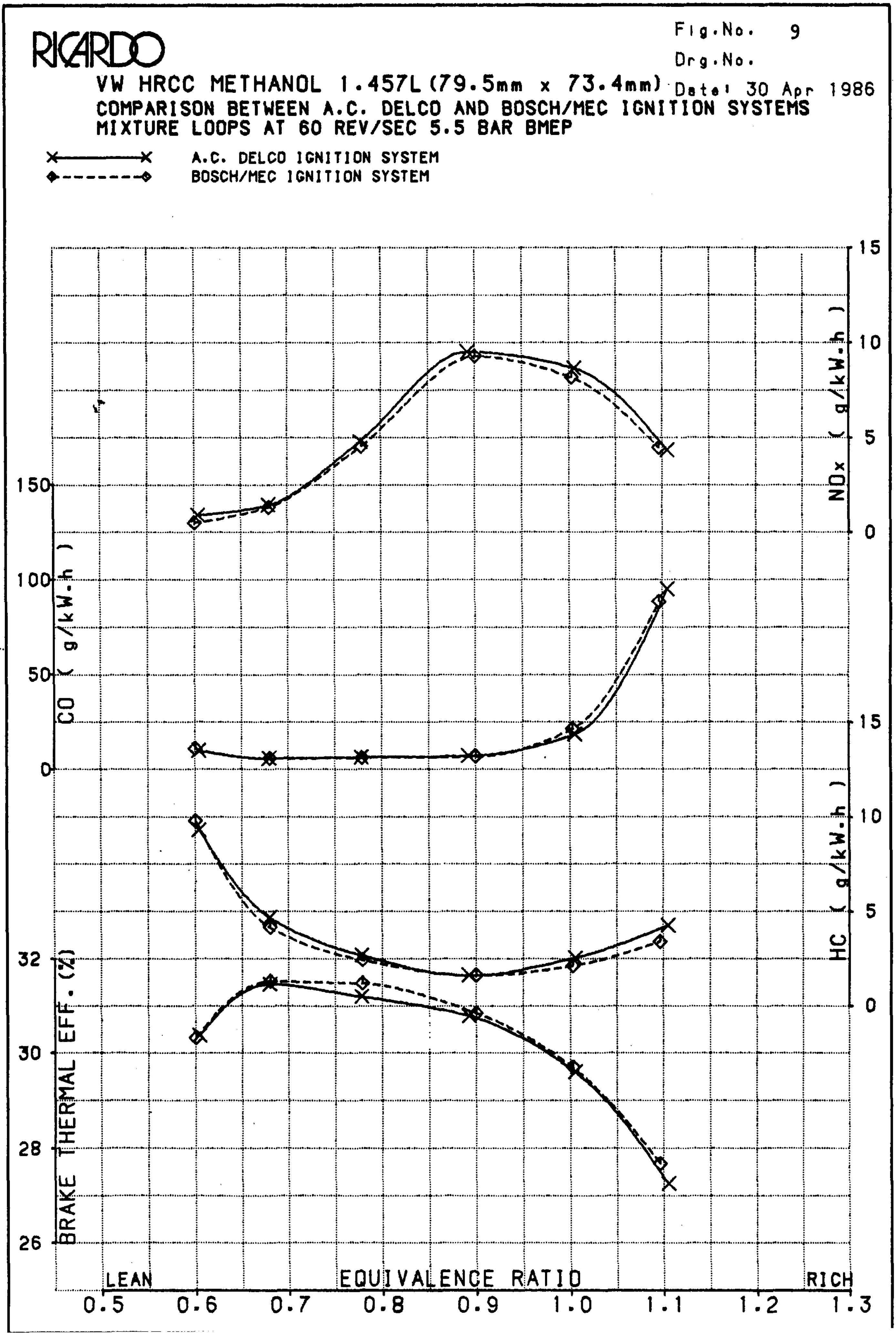
COMPARISON BETWEEN A.C. DELCO AND BOSCH/MEC IGNITION SYSTEMS MIXTURE LOOPS AT 40 REV/SEC 2.5 BAR BMEP





RICARDO
Fig.No. 7
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN A.C. DELCO AND BOSCH/MEC IGNITION SYSTEMS
MIXTURE LOOPS AT 40 REV/SEC 2.5 BAR BMEP
A.C. DELCO IGNITION SYSTEM
BOSCH/MEC IGNITION SYSTEM
NOx (PPM)
3000
2000
1000
0
CO (%)
3
2
1
0
HC (PPMc)
6000
4000
2000
0
LEAN
EQUIVALENCE RATIO
RICH
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3


RICARDO
Fig.No. 8
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN A.C. DELCO AND BOSCH/MEC IGNITION SYSTEMS
MIXTURE LOOPS AT 40 REV/SEC 2.5 BAR BMEP
A.C. DELCO IGNITION SYSTEM
BOSCH/MEC IGNITION SYSTEM
HC+NOx (g/kW.h)
BRAKE THERMAL EFFICIENCY (%)
30
25
20
15
10
5
28
26
24
22
20
18
LEAN
EQUIVALENCE RATIO
RICH
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3


RICARDO
Fig.No. 9
Drg.No.
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
Date: 30 Apr 1986
COMPARISON BETWEEN A.C. DELCO AND BOSCH/MEC IGNITION SYSTEMS
MIXTURE LOOPS AT 60 REV/SEC 5.5 BAR BMEP
A.C. DELCO IGNITION SYSTEM
BOSCH/MEC IGNITION SYSTEM
NOx (g/kW.h)
15
10
5
0
CO (g/kW.h)
150
100
50
0
HC (g/kW.h)
15
10
5
0
BRAKE THERMAL EFF. (%)
32
30
28
26
LEAN
EQUIVALENCE RATIO
RICH
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3

RICARDO

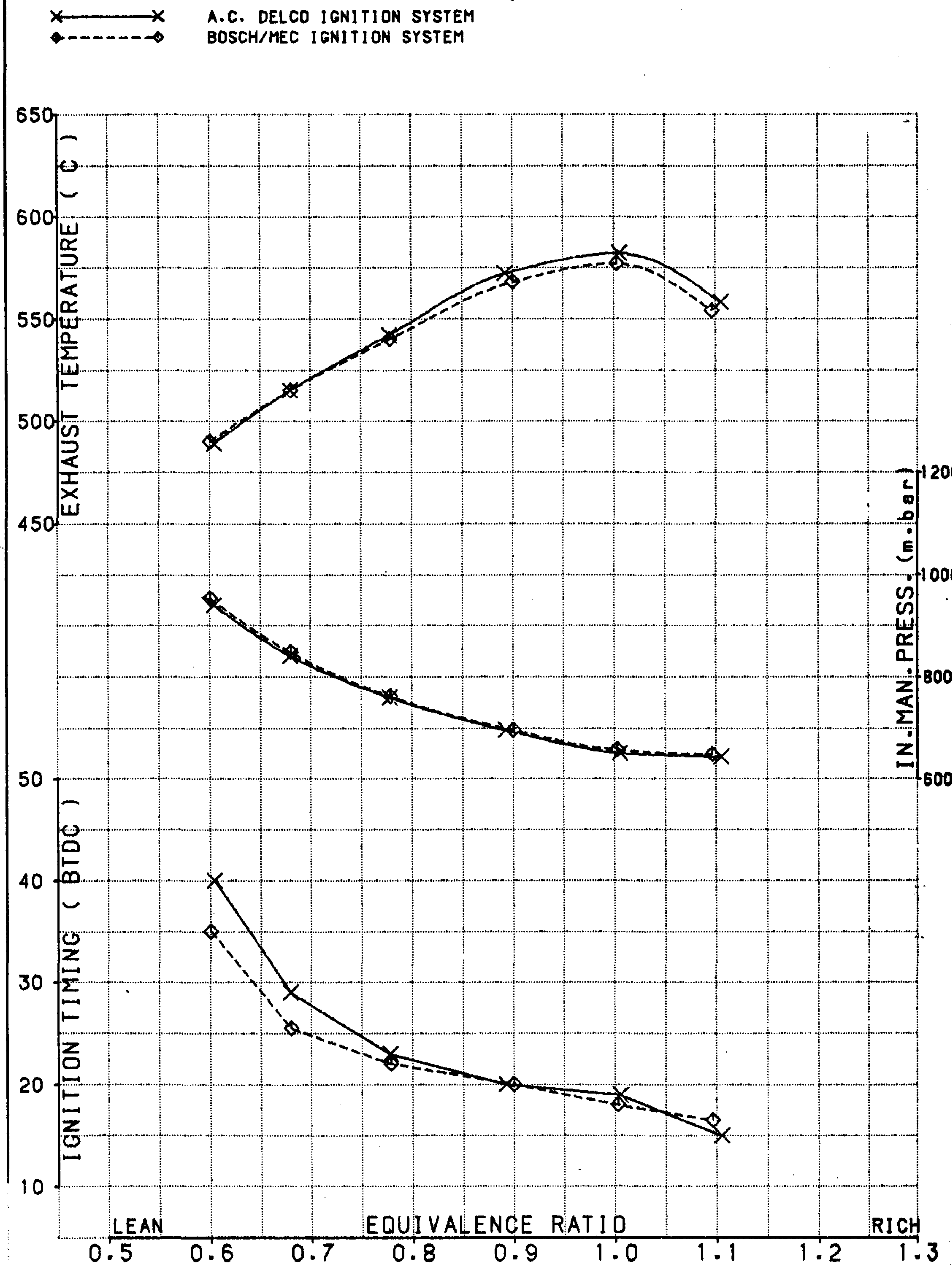
Fig.No. 10

Drg.No.

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm) Date: 30 Apr 1986

COMPARISON BETWEEN A.C. DELCO AND BOSCH/MEC IGNITION SYSTEMS

MIXTURE LOOPS AT 60 REV/SEC 5.5 BAR BMEP



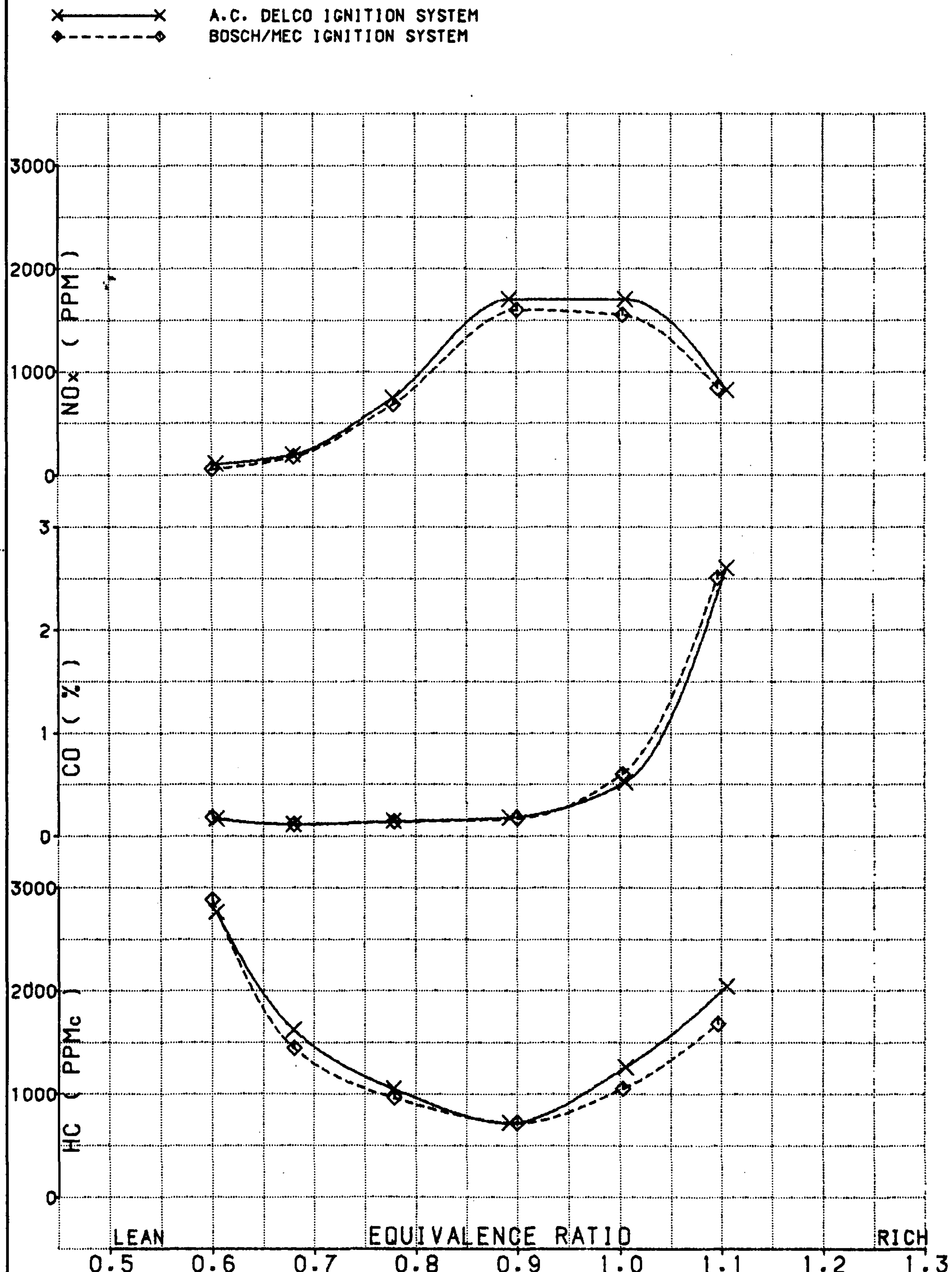
RICARDO

Fig.No. 11

Drg.No.

Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN A.C. DELCO AND BOSCH/MEC IGNITION SYSTEMS
MIXTURE LOOPS AT 60 REV/SEC 5.5 BAR BMEP



RICARDO

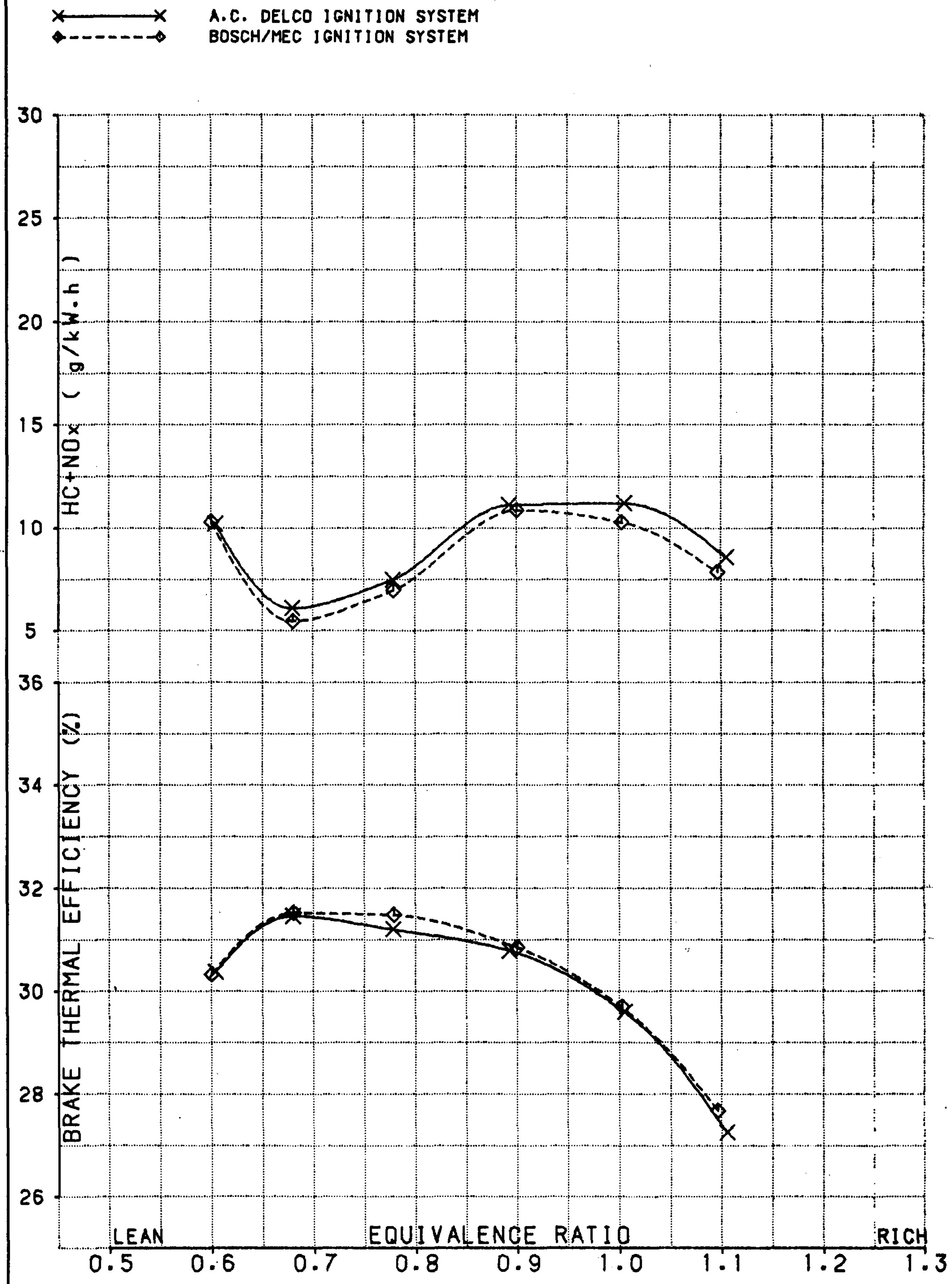
Fig. No. 12

Drg. No.

Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

COMPARISON BETWEEN A.C. DELCO AND BOSCH/MEC IGNITION SYSTEMS
MIXTURE LOOPS AT 60 REV/SEC 5.5 BAR BMEP



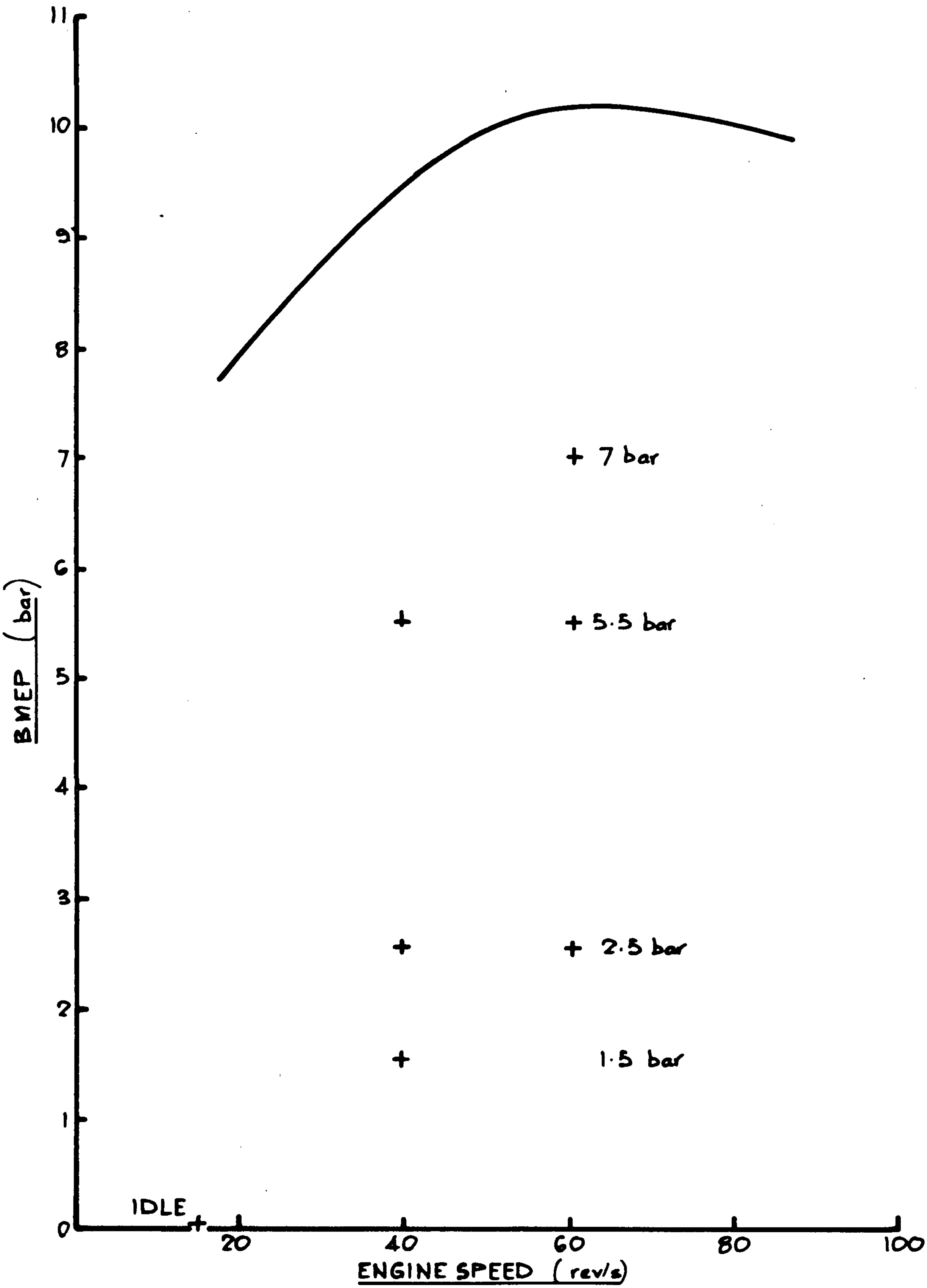
GL/BF

RICARDO

FIG. No. 13
Drg. No. S11862
Date MARCH '86

VW HRCC METHANOL 1·475l (79·5 mm x 73·4 mm)

ENGINE KEY-POINT OPERATING CONDITIONS



RICARDO

Fig.No. 14

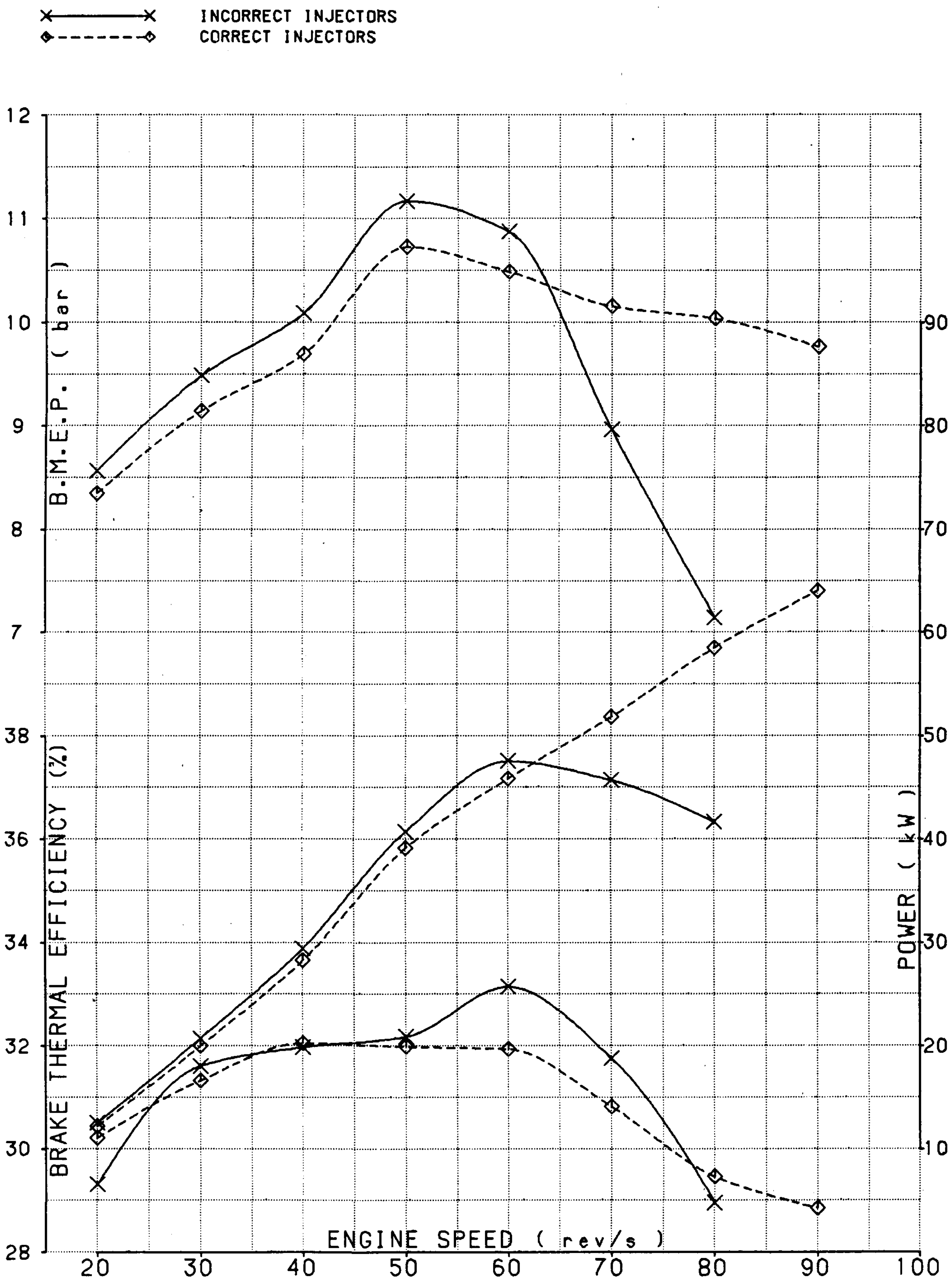
Drg.No.

Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS

FULL LOAD POWER CURVE MBT IGNITION TIMING



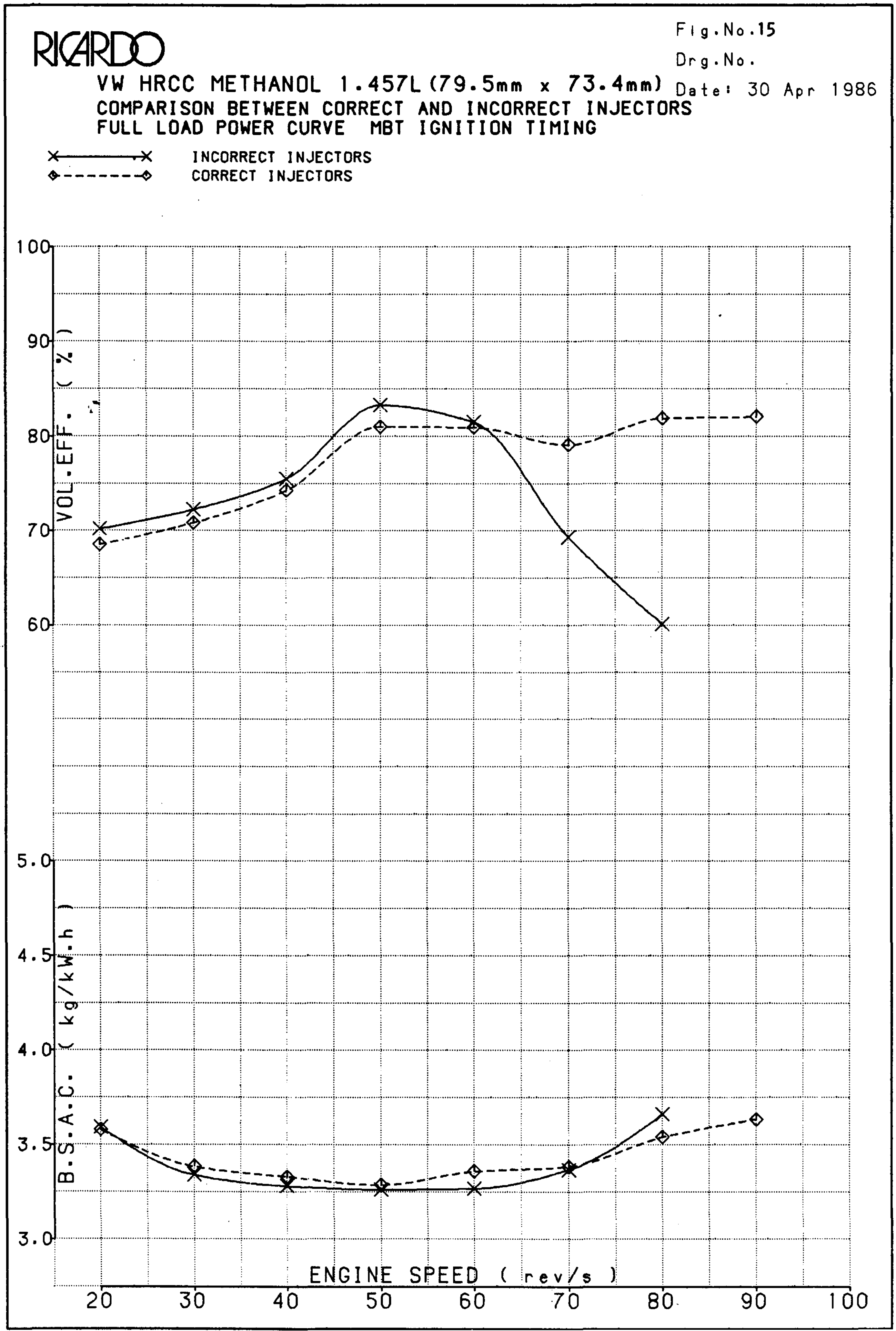

RICARDO
Fig.No.15
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
FULL LOAD POWER CURVE MBT IGNITION TIMING
INCORRECT INJECTORS
CORRECT INJECTORS
VOL.EFF. (%)
B.S.A.C. (kg/kW.h)
ENGINE SPEED (rev/s)
100
90
80
70
60
5.0
4.5
4.0
3.5
3.0
20
30
40
50
60
70
80
90
100

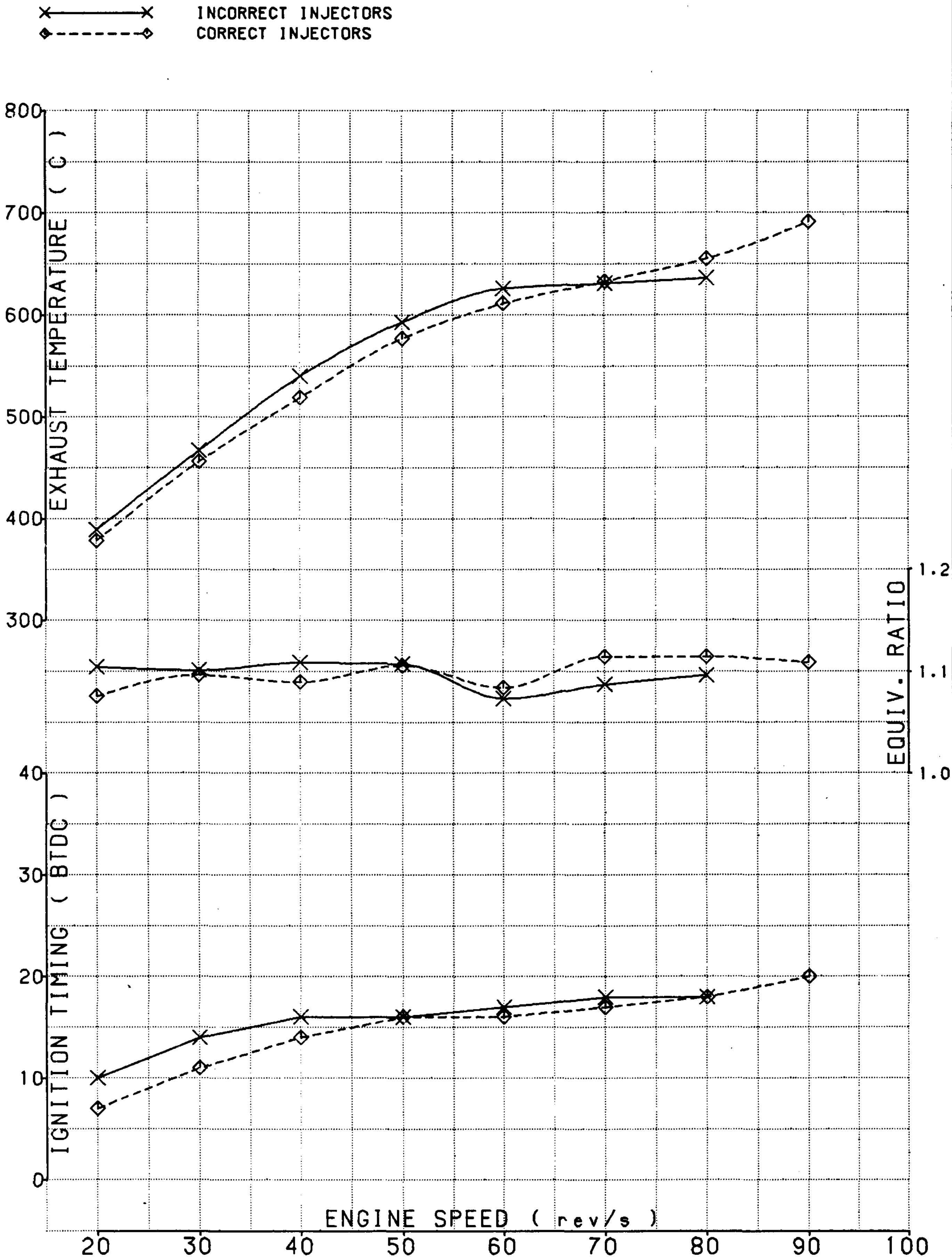
Fig. No. 16

Drg. No.

Date: 30 Apr 1986

RICARDO

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
FULL LOAD POWER CURVE MBT IGNITION TIMING



RICARDO

Fig. No. 17

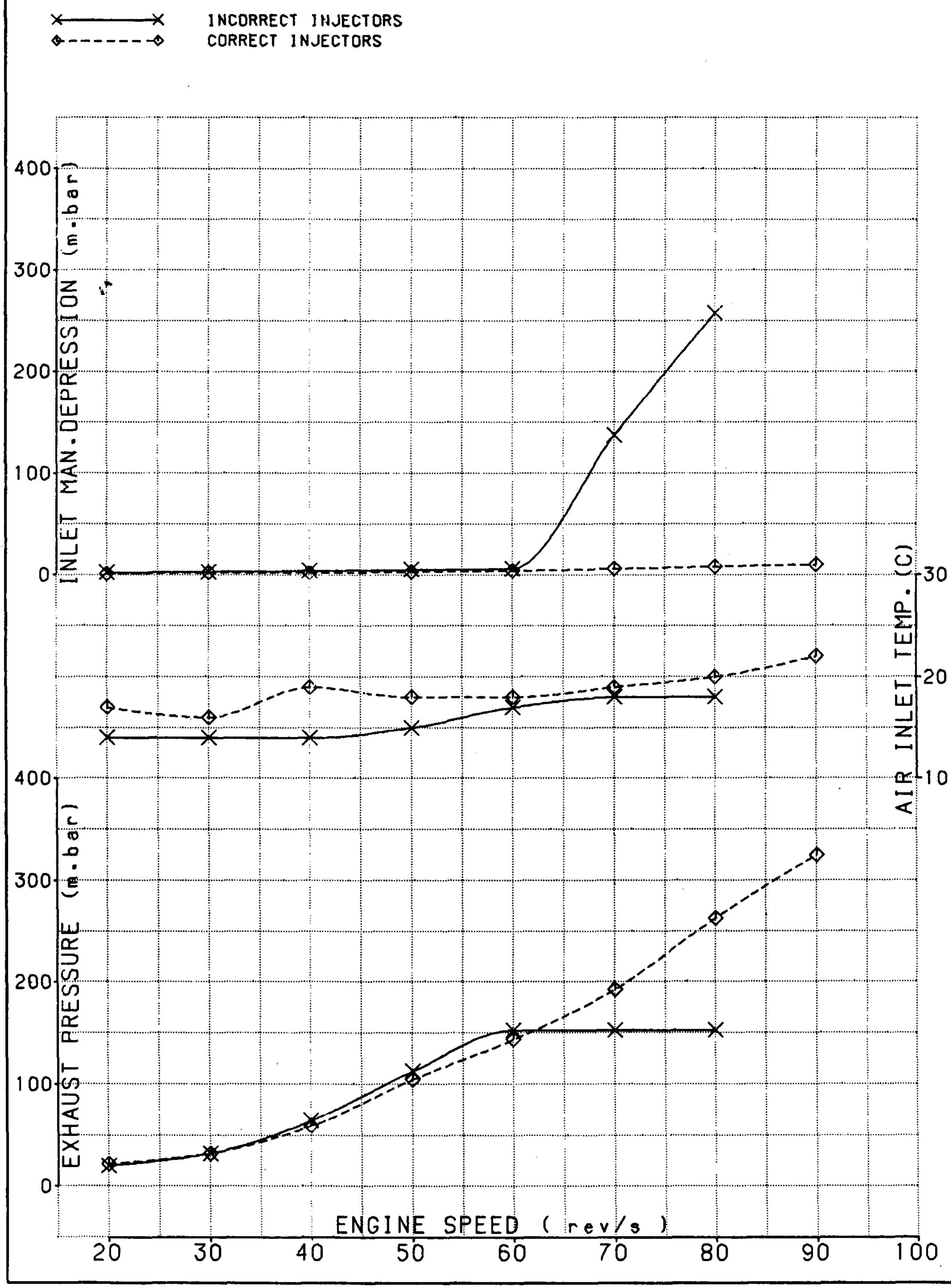
Drg. No.

Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS

FULL LOAD POWER CURVE MBT IGNITION TIMING



RICARDO

FIG. No. 18

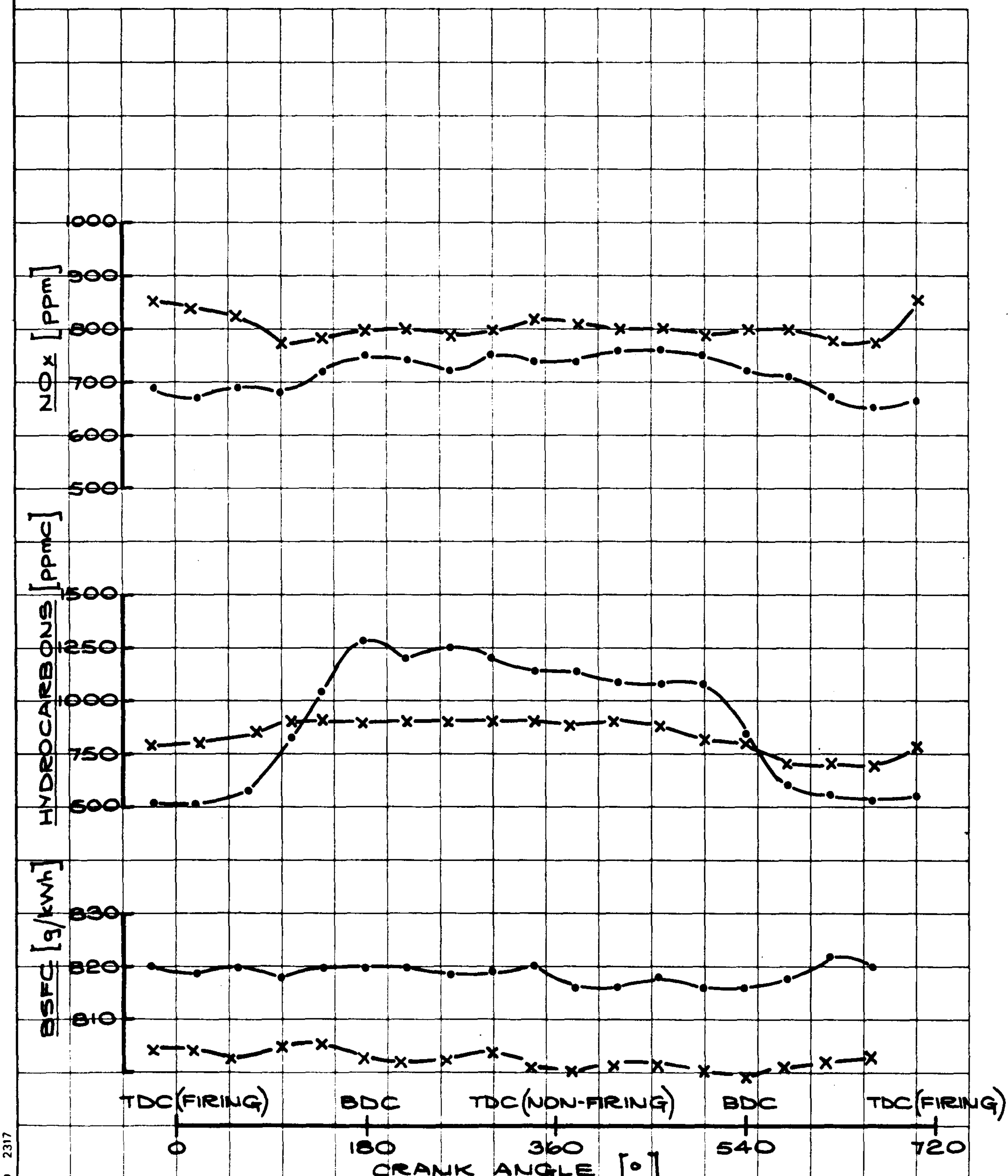
Drg. No. D55133

Date APRIL '8

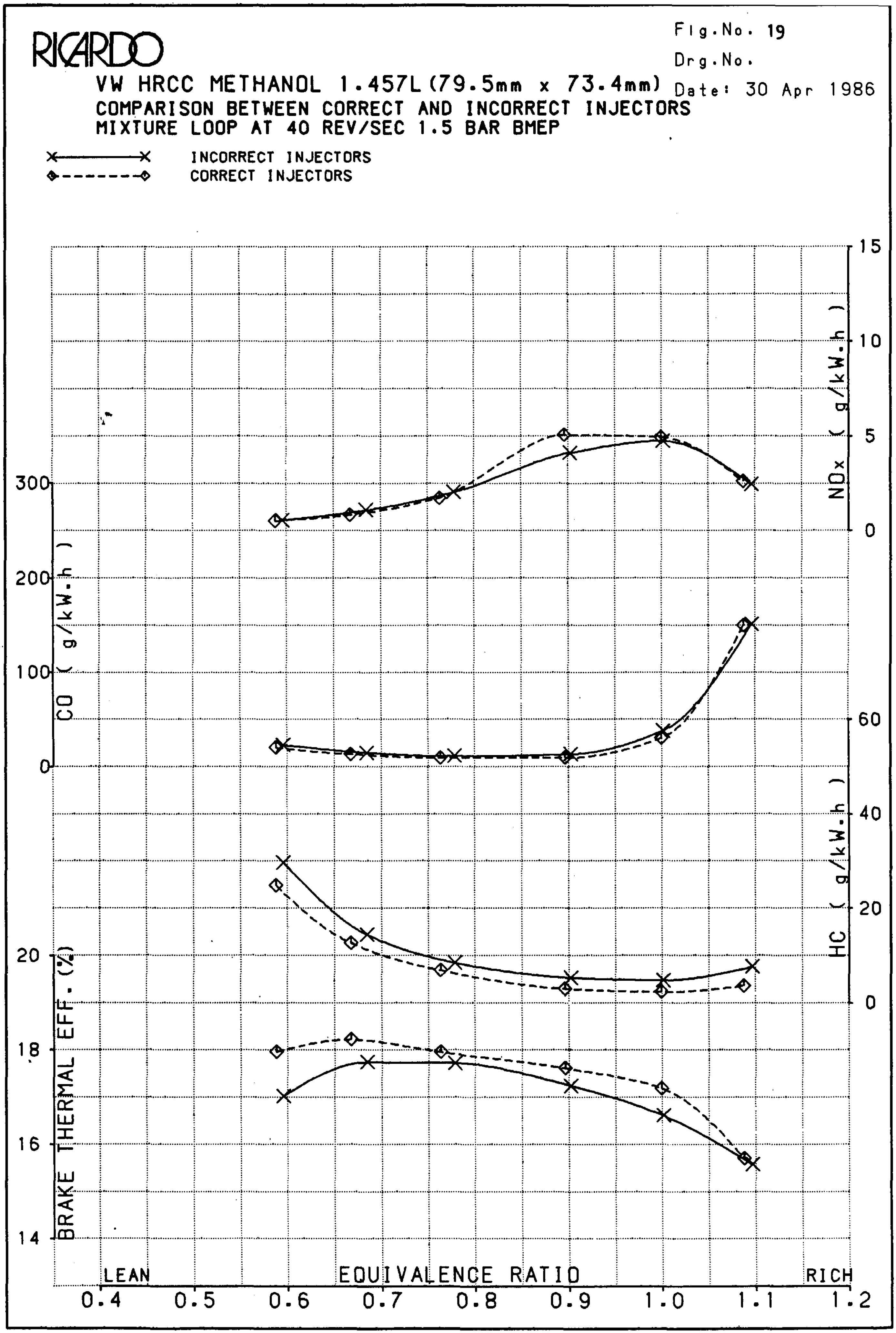
VW HRCC METHANOL 1·457ℓ (79·5mm x 73·4mm)
EFFECT OF FUEL INJECTION TIMING ON
EXHAUST EMISSIONS AND FUEL CONSUMPTION
AT 2400 rev/min 2·5 bar BMEP, STOICHIOMETRIC A.F.R.

x———x CORRECT SIZE INJECTORS
•———• UNDERSIZE INJECTORS

INJECTION PERIOD ≙ 75 DEGREES WITH CORRECT SIZE INJECTORS
INJECTION PERIOD ≙ 140 DEGREES WITH UNDERSIZE INJECTORS



V M LTD 2317



RICARDO
Fig.No. 19
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
MIXTURE LOOP AT 40 REV/SEC 1.5 BAR BMEP
INCORRECT INJECTORS
CORRECT INJECTORS
NOx (g/kW.h)
CO (g/kW.h)
HC (g/kW.h)
BRAKE THERMAL EFF. (%)
LEAN
EQUIVALENCE RATIO
RICH
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2

RICARDO

Fig.No. 20

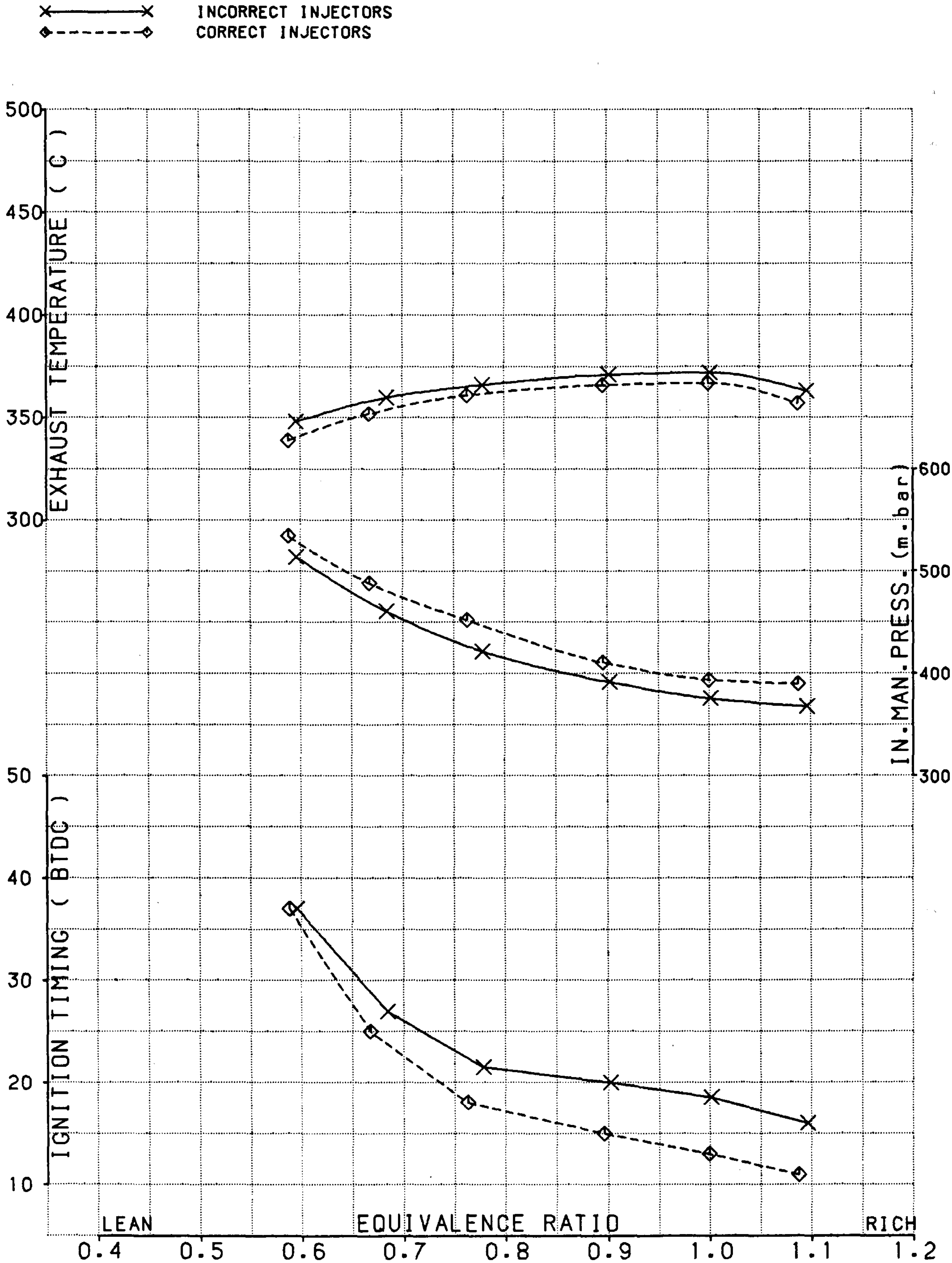
Drg.No.

Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS

MIXTURE LOOP AT 40 REV/SEC 1.5 BAR BMEP



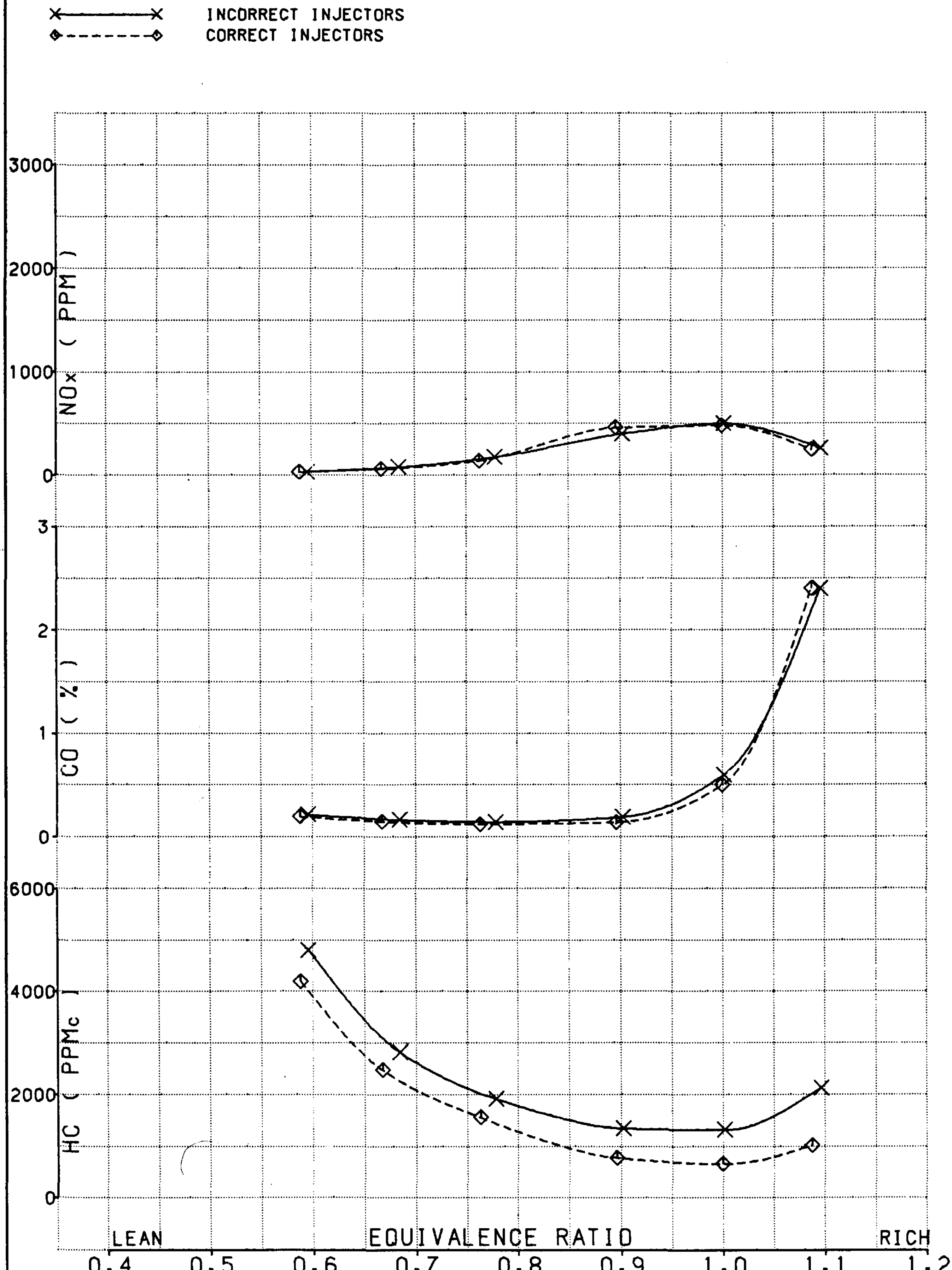
RICARDO

Fig.No.21

Drg.No.

Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
MIXTURE LOOP AT 40 REV/SEC 1.5 BAR BMEP



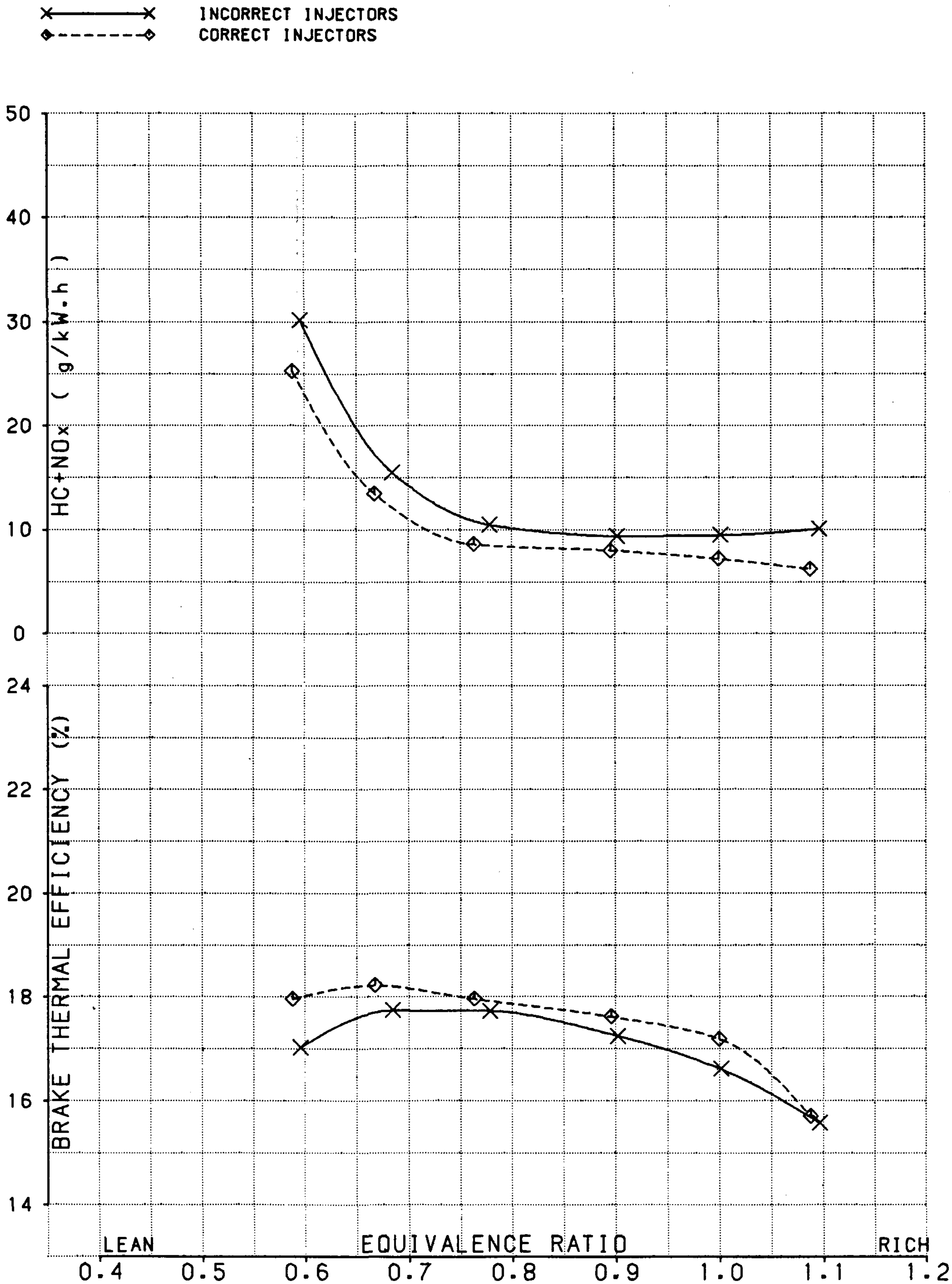
RICARDO

Fig.No. 22

Drg.No.

Date: 30 Apr 1986

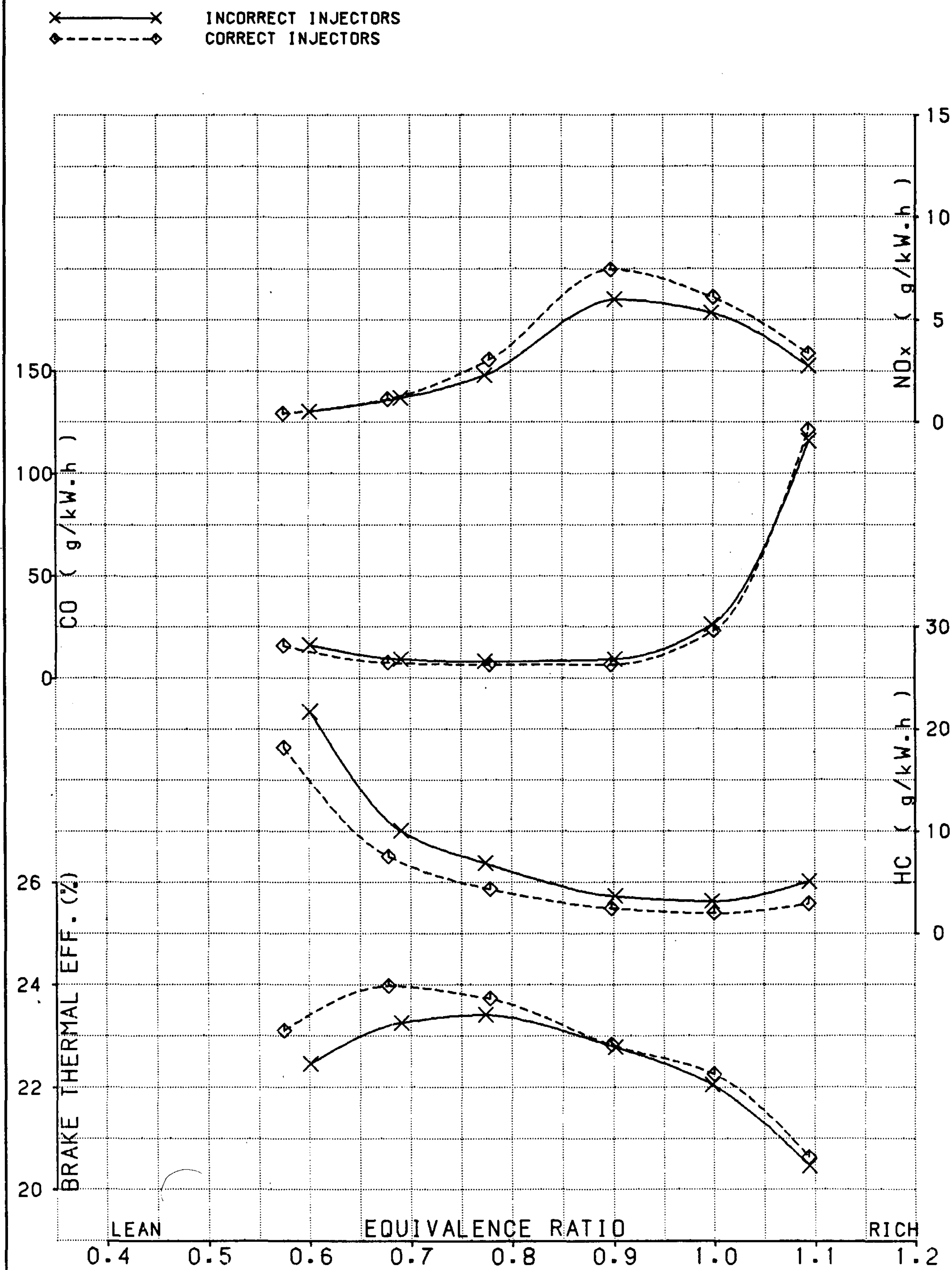
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
MIXTURE LOOP AT 40 REV/SEC 1.5 BAR BMEP

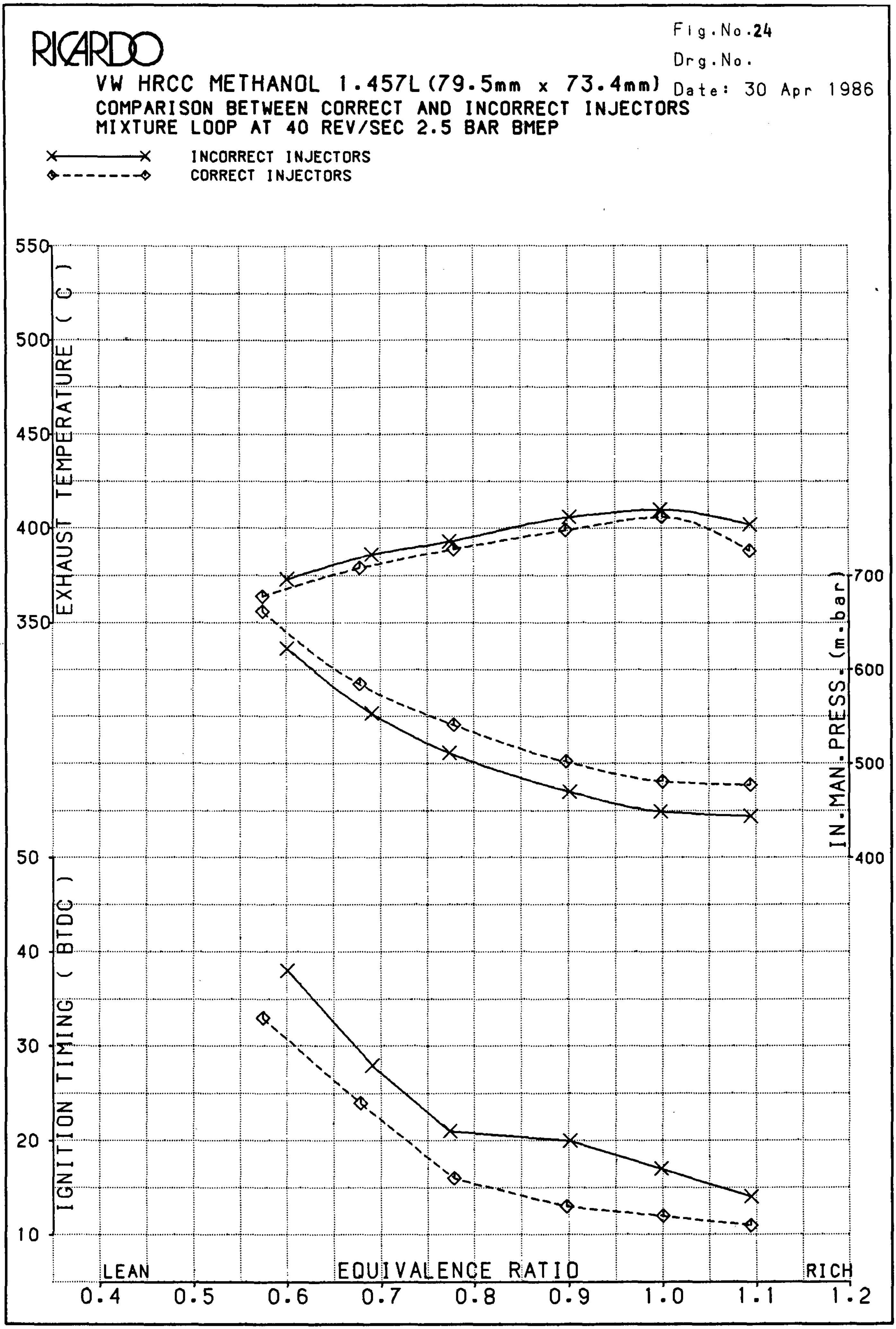


RICARDO

Fig.No. 23
Drg.No.
Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
MIXTURE LOOP AT 40 REV/SEC 2.5 BAR BMEP




RICARDO
Fig.No.24
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
MIXTURE LOOP AT 40 REV/SEC 2.5 BAR BMEP
INCORRECT INJECTORS
CORRECT INJECTORS
EXHAUST TEMPERATURE (C)
550
500
450
400
350
IN.MAN.PRESS. (m.bar)
700
600
500
400
IGNITION TIMING (BTDC)
50
40
30
20
10
LEAN
EQUIVALENCE RATIO
RICH
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2

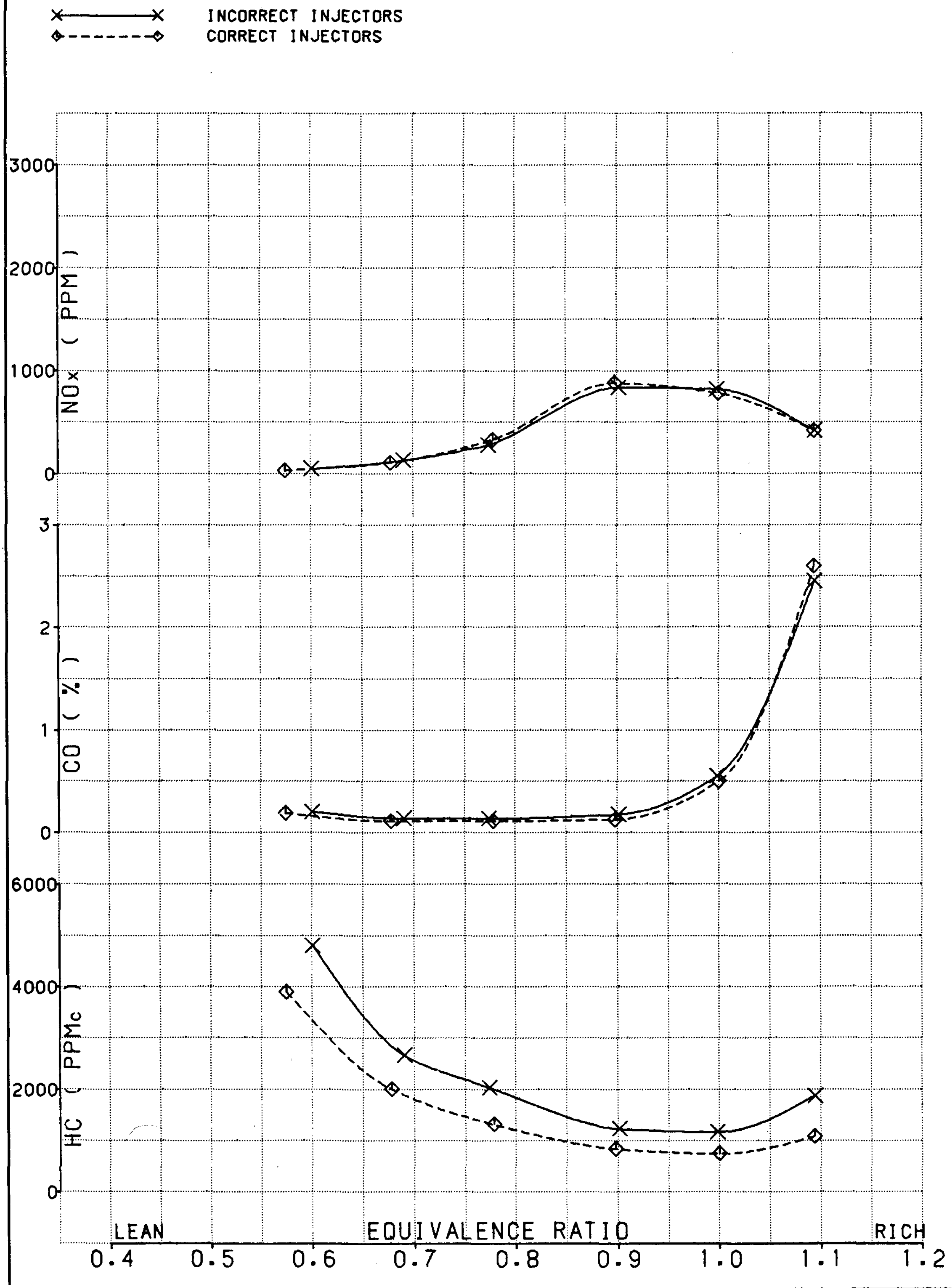
RICARDO

Fig.No. 25

Drg.No.

Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
MIXTURE LOOP AT 40 REV/SEC 2.5 BAR BMEP



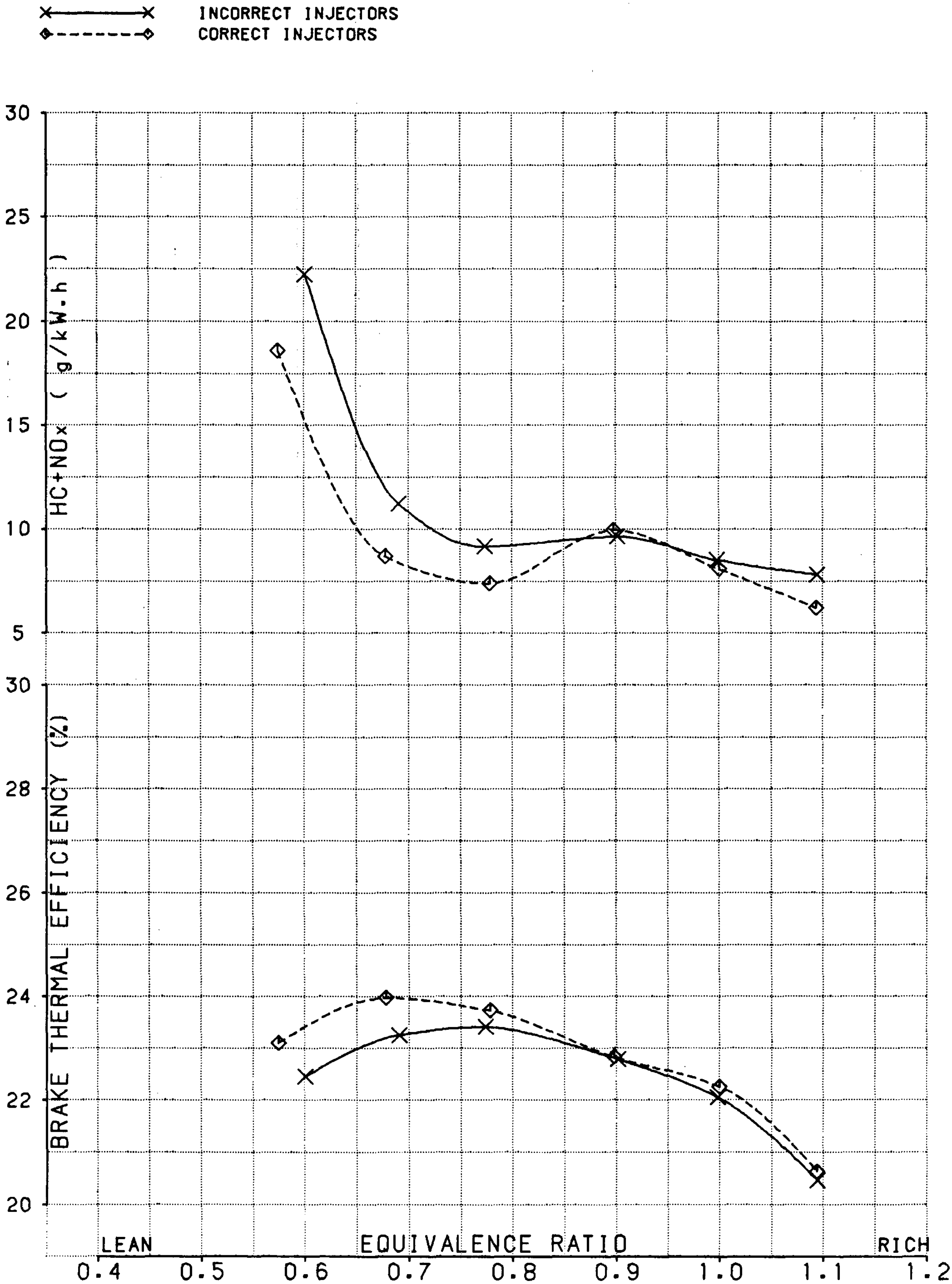
RICARDO

Fig.No. 26

Drg.No.

Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
MIXTURE LOOP AT 40 REV/SEC 2.5 BAR BMEP



RICARDO

Fig. No. 27

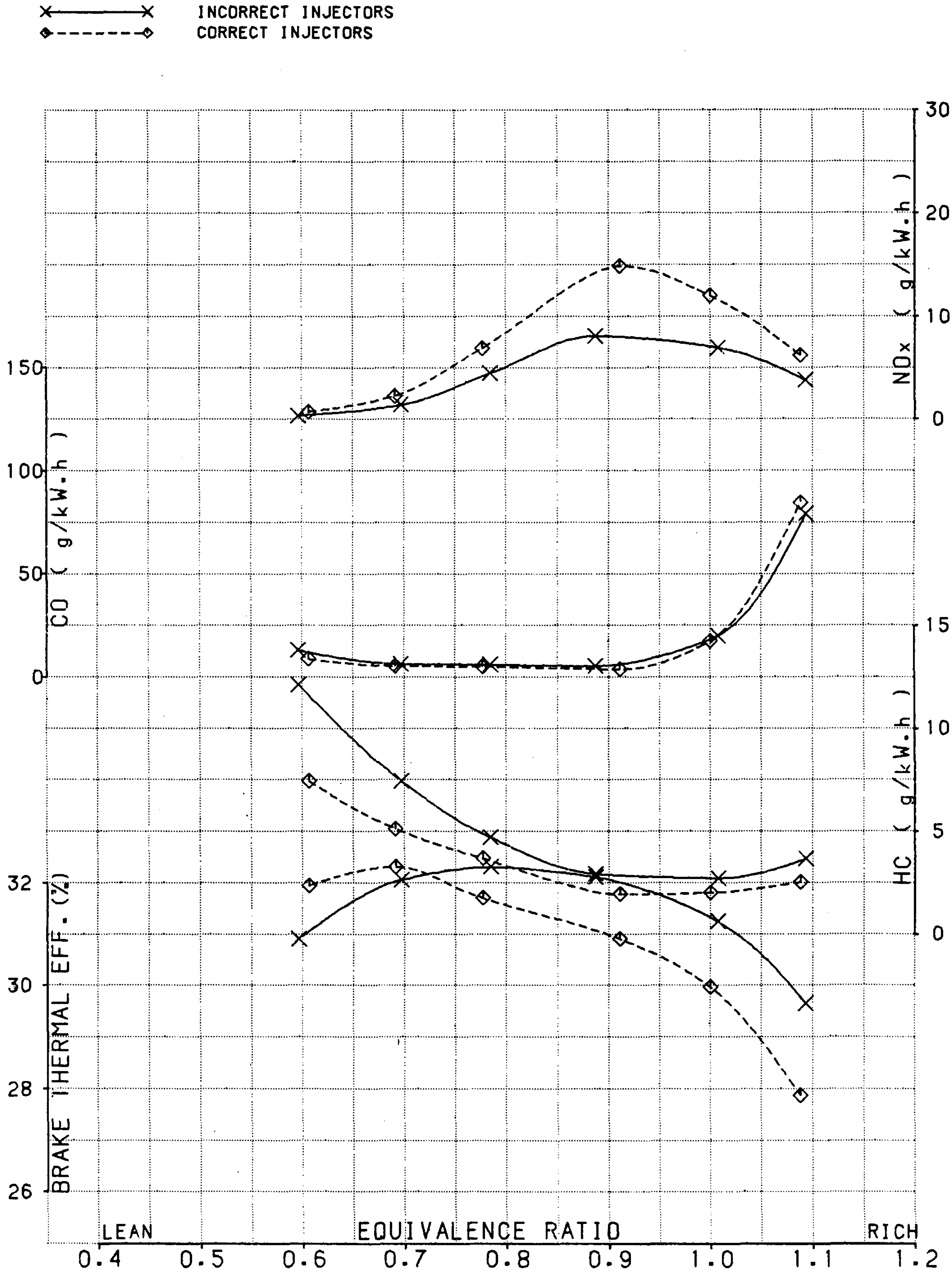
Drg. No.

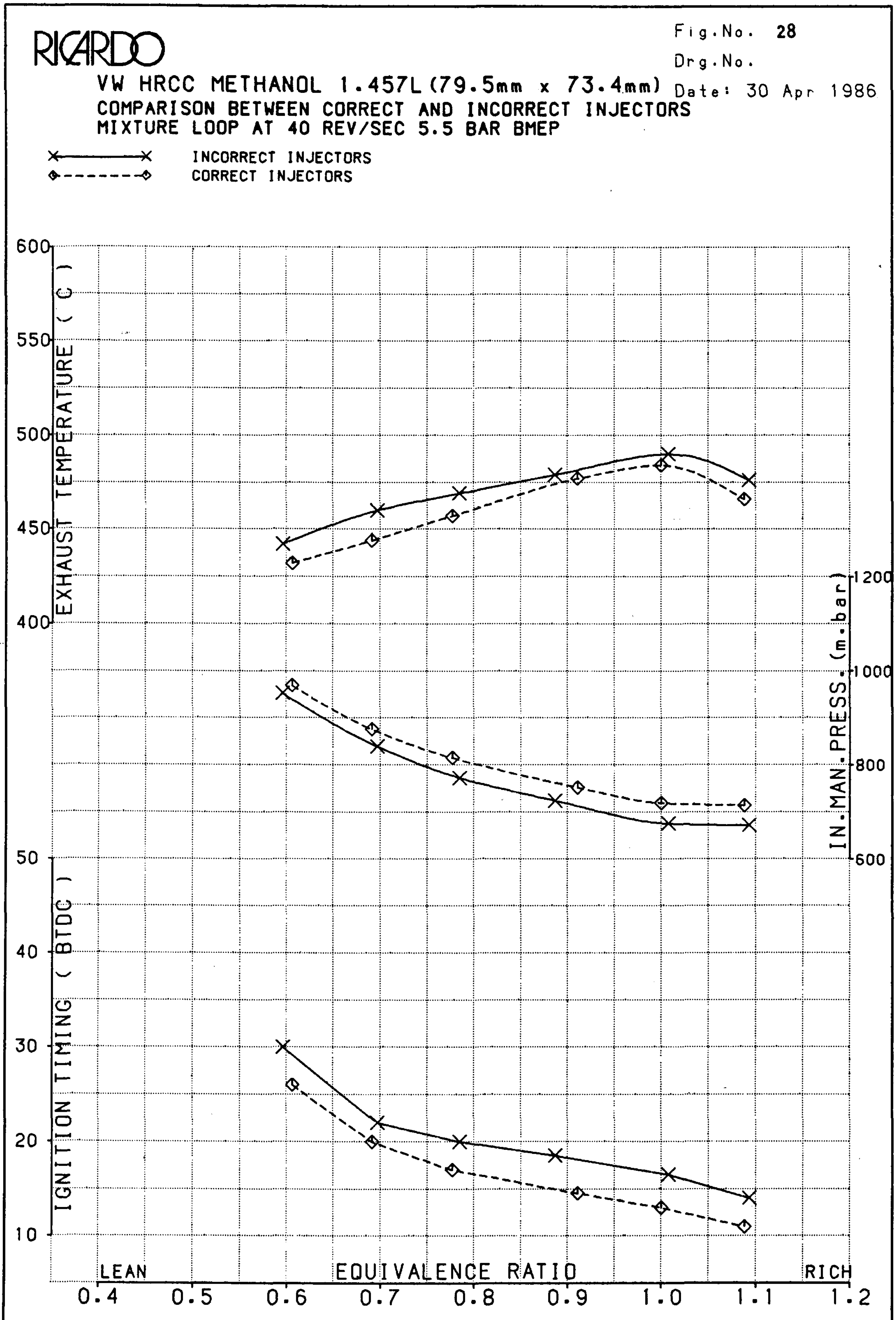
Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS

MIXTURE LOOP AT 40 REV/SEC 5.5 BAR BMEP



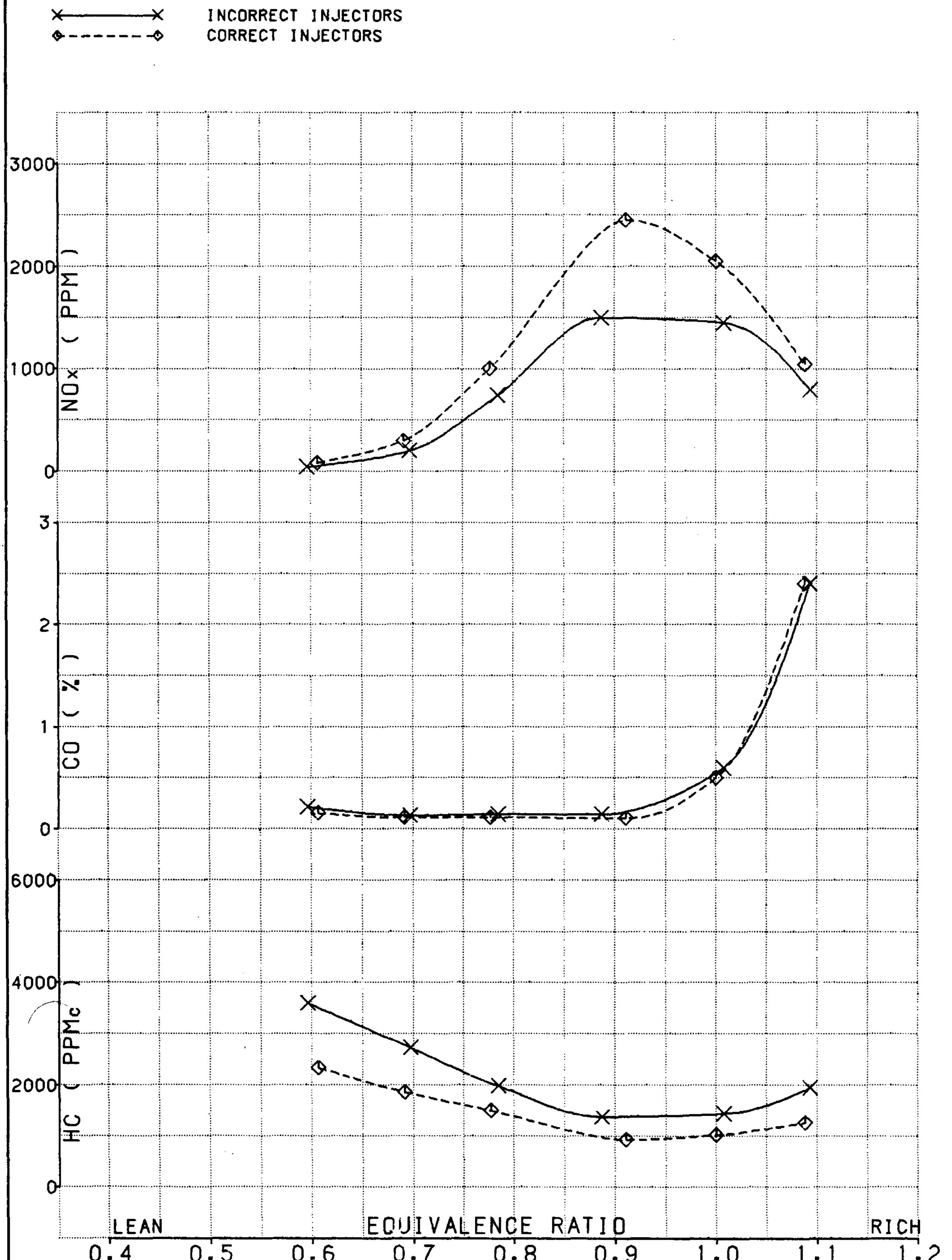


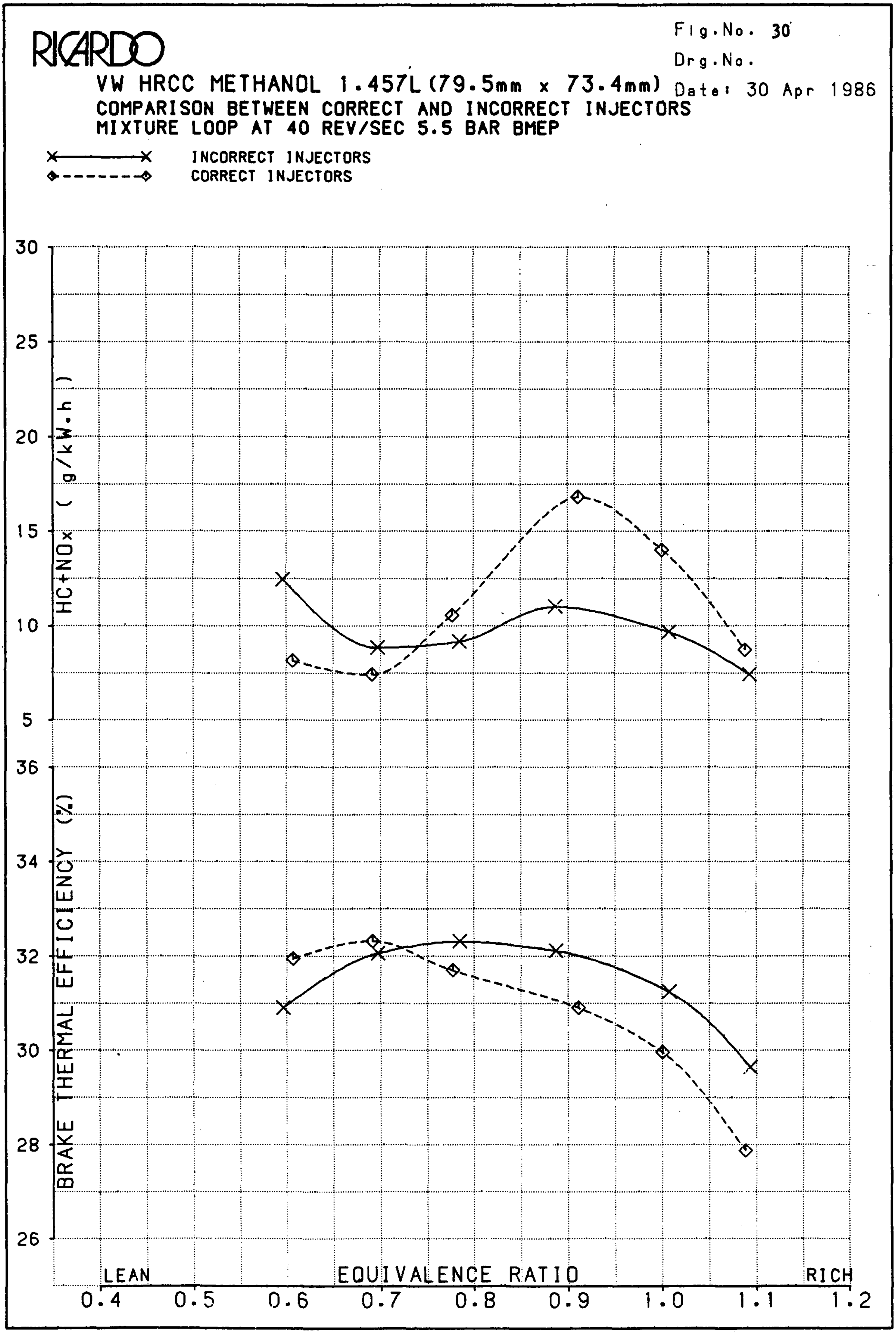
RICARDO
Fig.No. 28
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
MIXTURE LOOP AT 40 REV/SEC 5.5 BAR BMEP
INCORRECT INJECTORS
CORRECT INJECTORS
EXHAUST TEMPERATURE (C)
600
550
500
450
400
IN.MAN.PRESS. (m.bar)
1200
1000
800
600
IGNITION TIMING (BTDC)
50
40
30
20
10
LEAN
EQUIVALENCE RATIO
RICH
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2

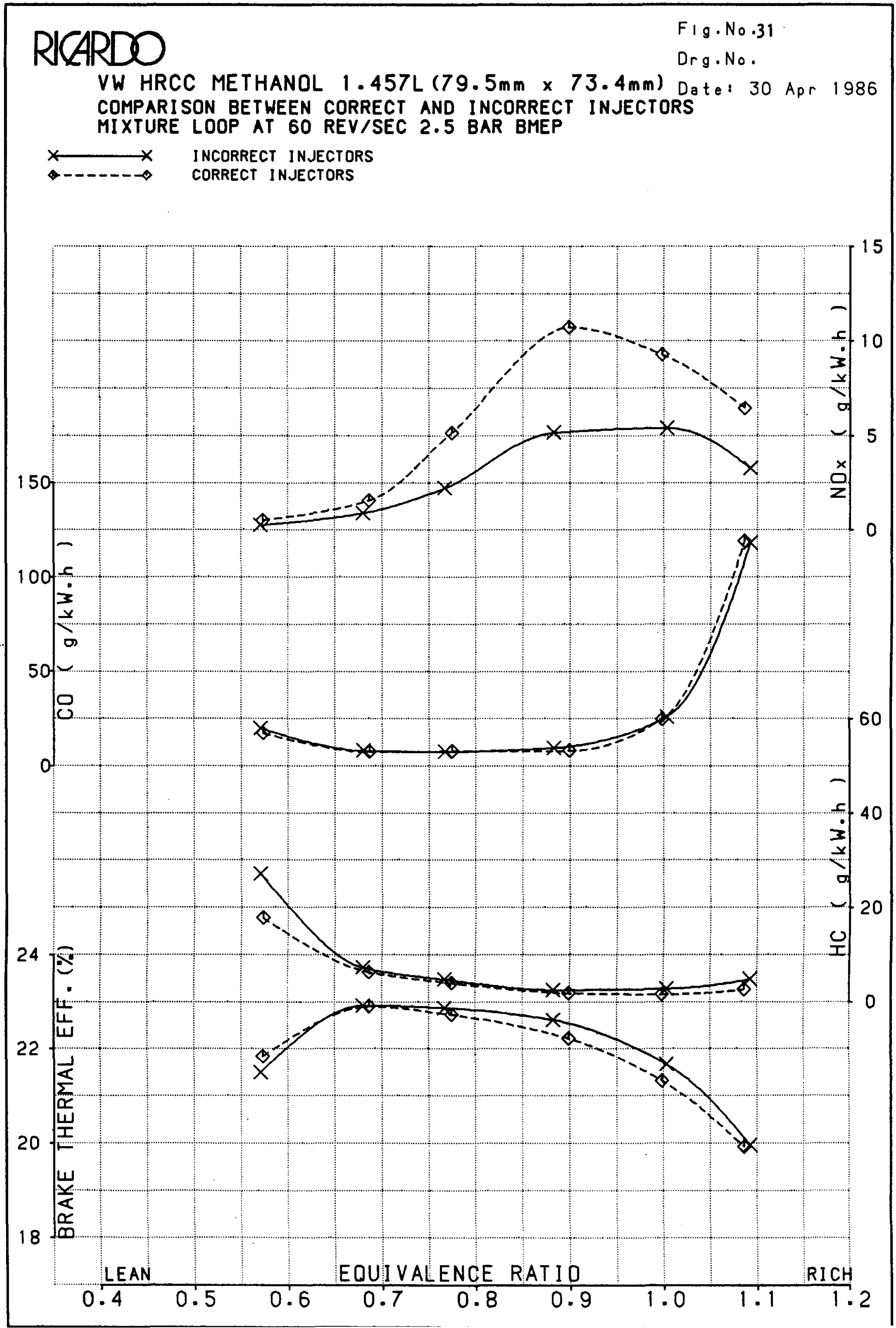
RICARDO

Fig.No. 29
Drg.No.
Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
MIXTURE LOOP AT 40 REV/SEC 5.5 BAR BMEP




RICARDO
Fig.No. 30
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
MIXTURE LOOP AT 40 REV/SEC 5.5 BAR BMEP
INCORRECT INJECTORS
CORRECT INJECTORS
HC+NOx (g/kW.h)
30
25
20
15
10
5
BRAKE THERMAL EFFICIENCY (%)
36
34
32
30
28
26
LEAN
EQUIVALENCE RATIO
RICH
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2



RICARDO
Fig.No.31
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
MIXTURE LOOP AT 60 REV/SEC 2.5 BAR BMEP
INCORRECT INJECTORS
CORRECT INJECTORS
NOx (g/kW.h)
15
10
5
0
CO (g/kW.h)
150
100
50
0
HC (g/kW.h)
60
40
20
0
BRAKE THERMAL EFF. (%)
24
22
20
18
LEAN
EQUIVALENCE RATIO
RICH
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2

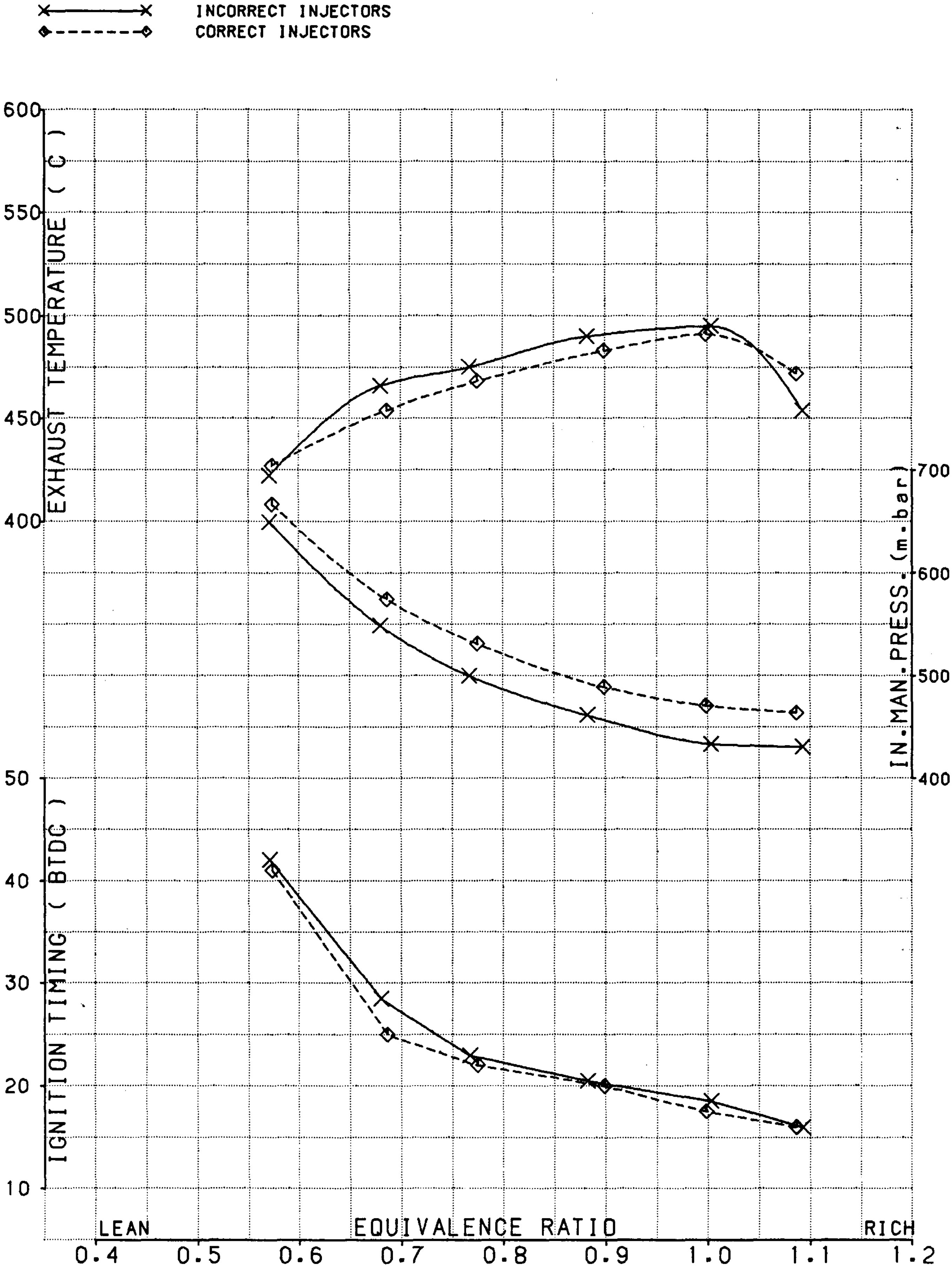
RICARDO

Fig.No. 32

Drg.No.

Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
MIXTURE LOOP AT 60 REV/SEC 2.5 BAR BMEP



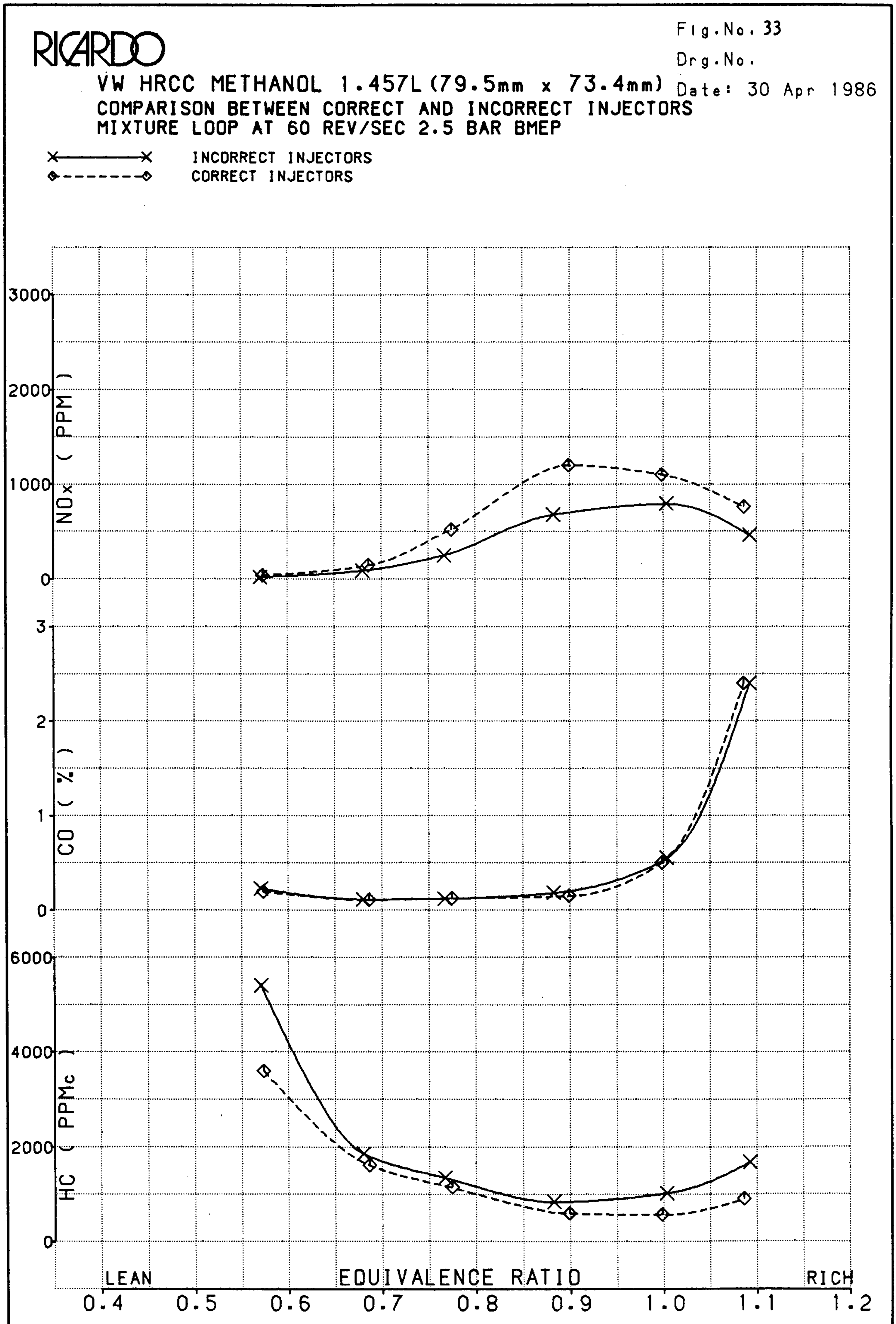
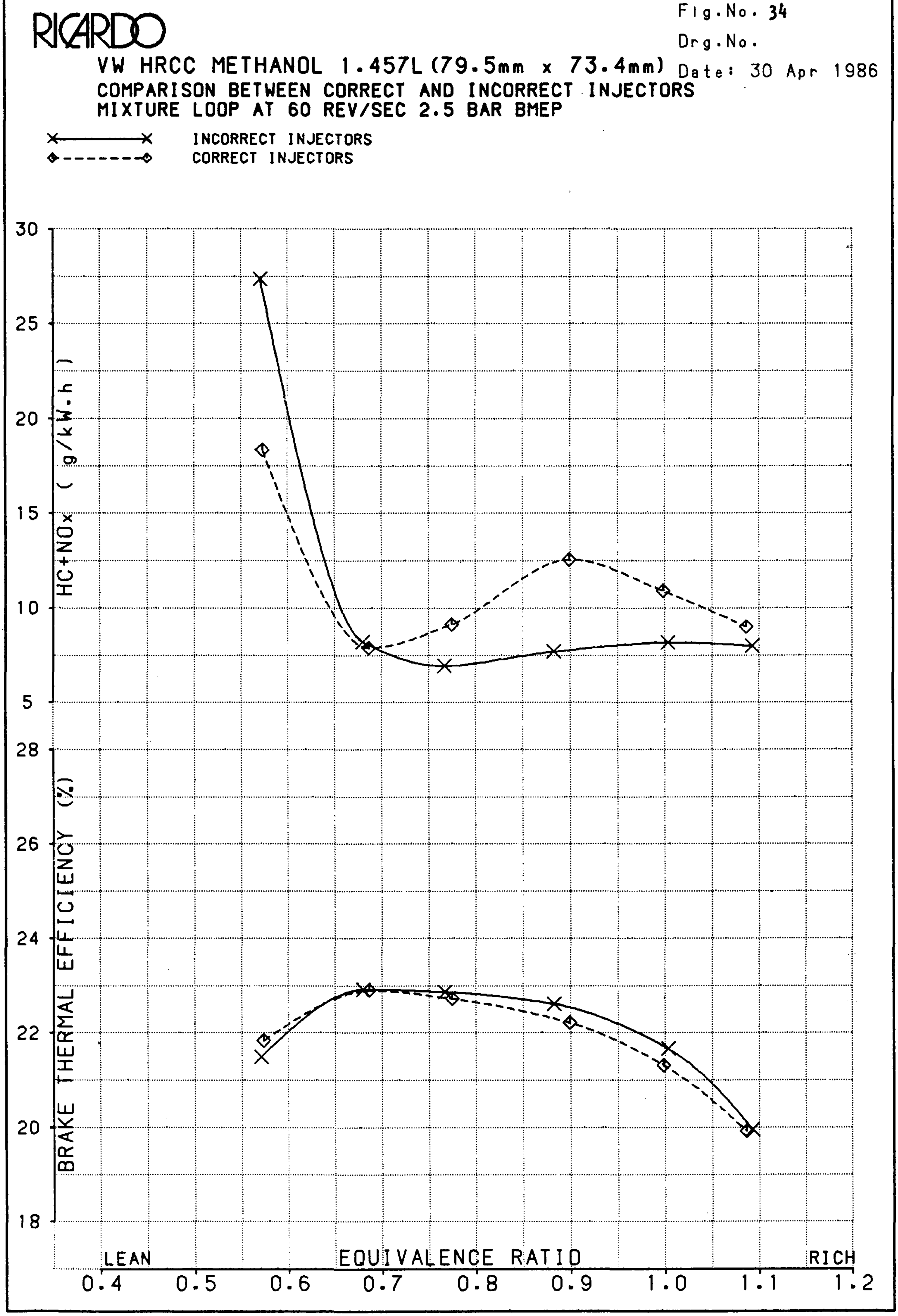

RICARDO
Fig.No. 33
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
MIXTURE LOOP AT 60 REV/SEC 2.5 BAR BMEP
INCORRECT INJECTORS
CORRECT INJECTORS
NOx (PPM)
3000
2000
1000
0
CO (%)
3
2
1
0
HC (PPMc)
6000
4000
2000
0
LEAN
EQUIVALENCE RATIO
RICH
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2

Fig.No. 34
Drg.No.
Date: 30 Apr 1986



RICARDO

Fig.No 35

Drg.No.

Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS

MIXTURE LOOP AT 60 REV/SEC 5.5 BAR BMEP

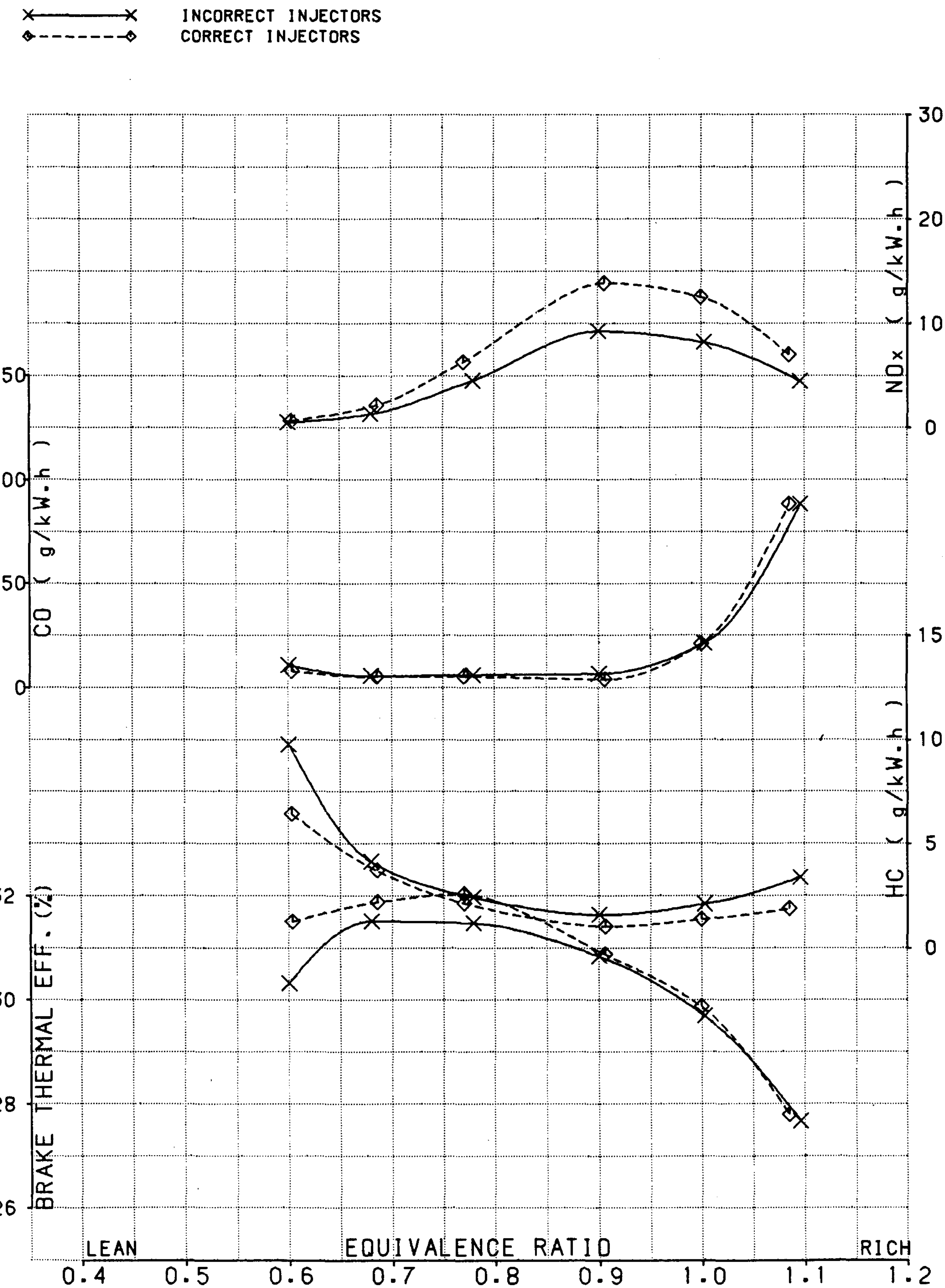
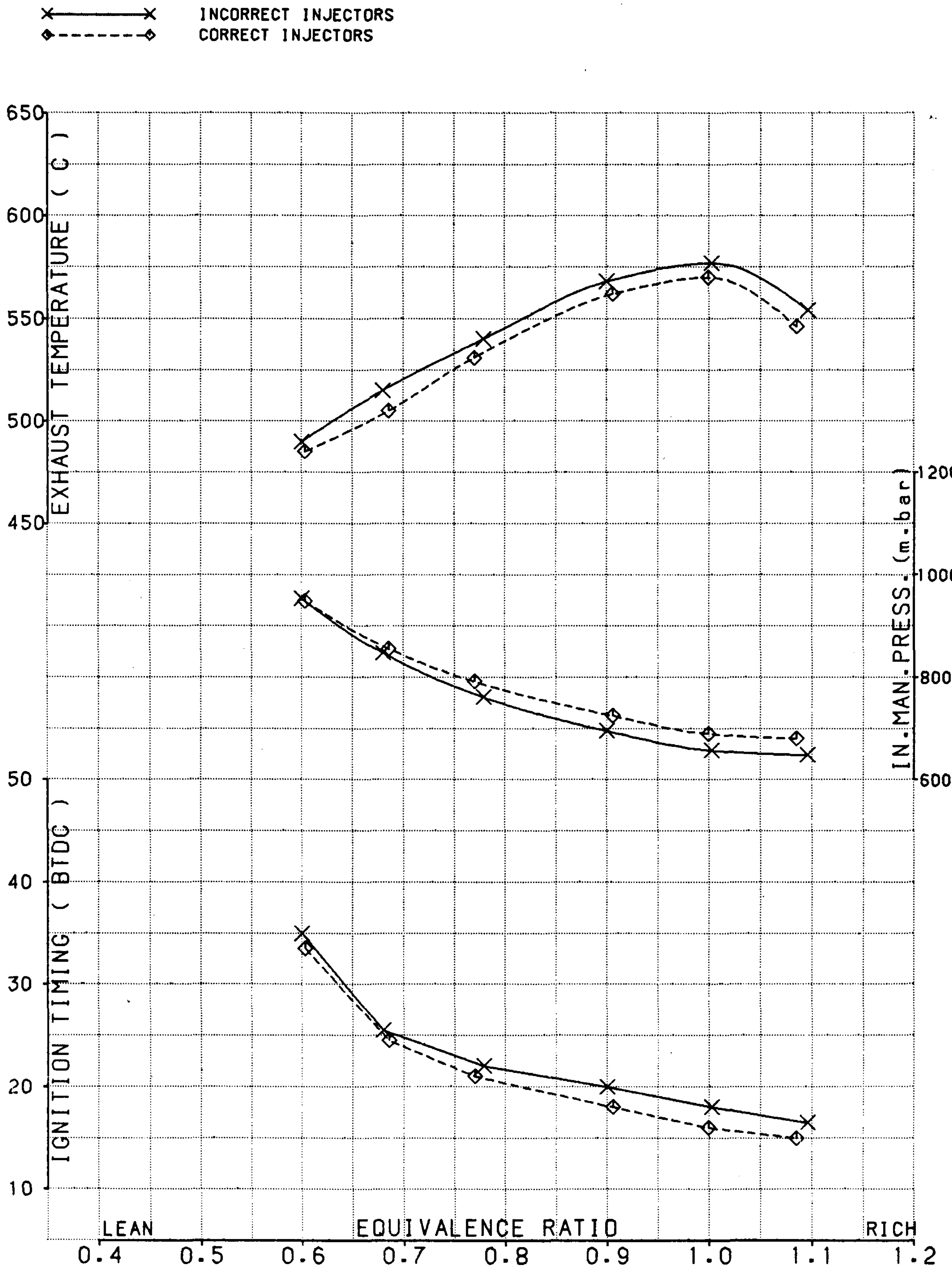


Fig. No. 36
Drg. No.
Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
MIXTURE LOOP AT 60 REV/SEC 5.5 BAR BMEP



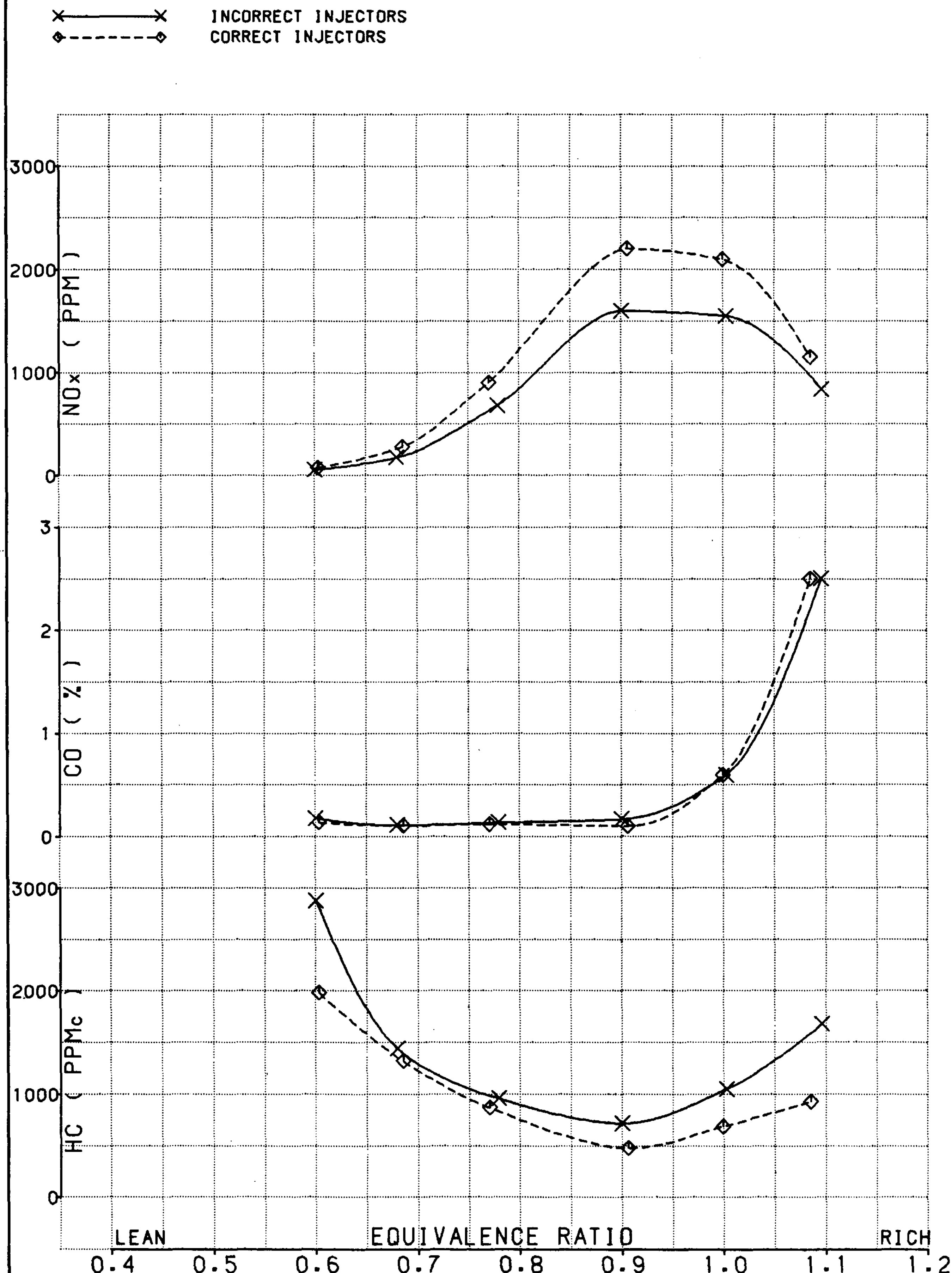
RICARDO

Fig. No. 37

Drg. No.

Date: 30 Apr 1986

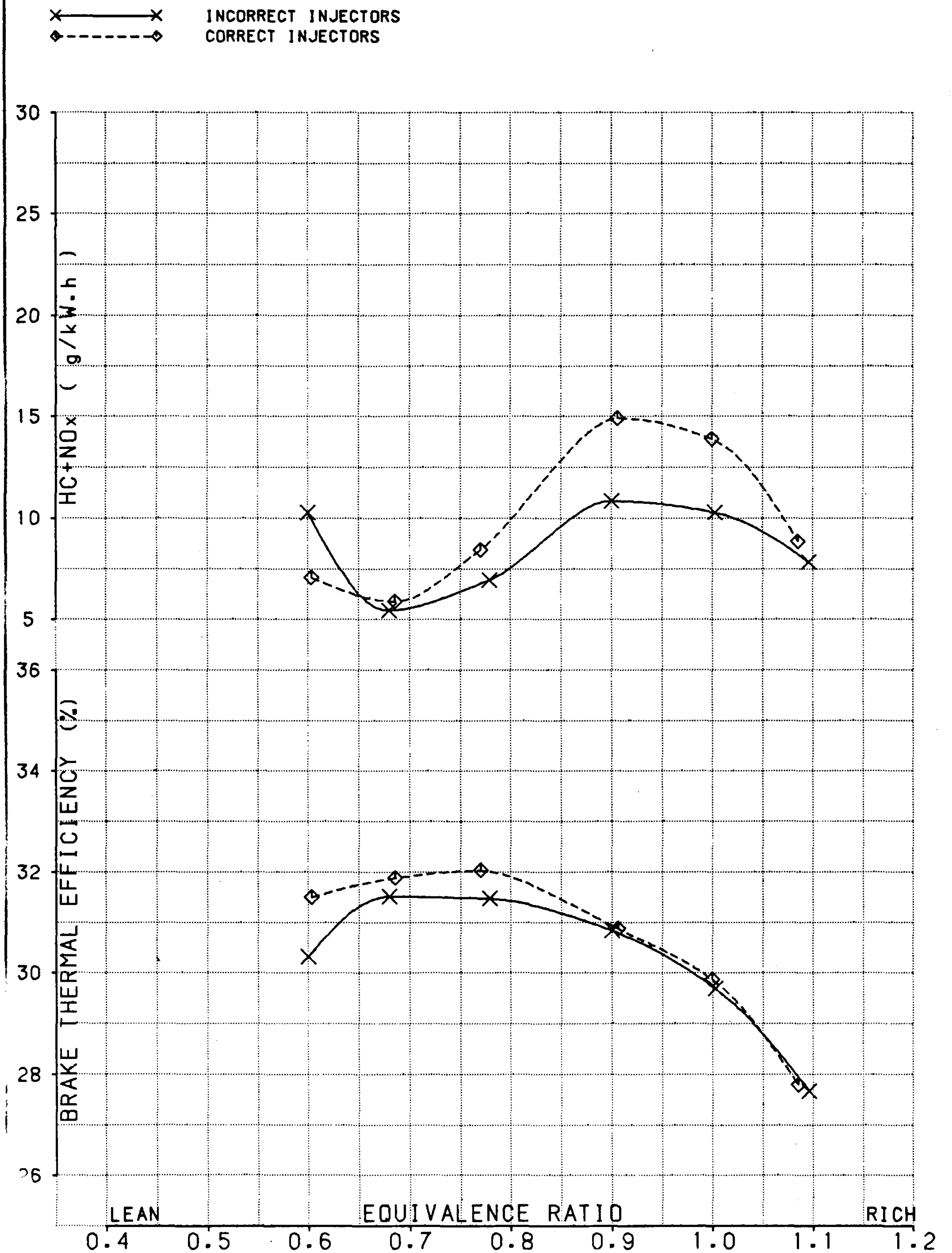
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
MIXTURE LOOP AT 60 REV/SEC 5.5 BAR BMEP



RICARDO

Fig.No. 38
Drg.No.
Date: 30 Apr 1986

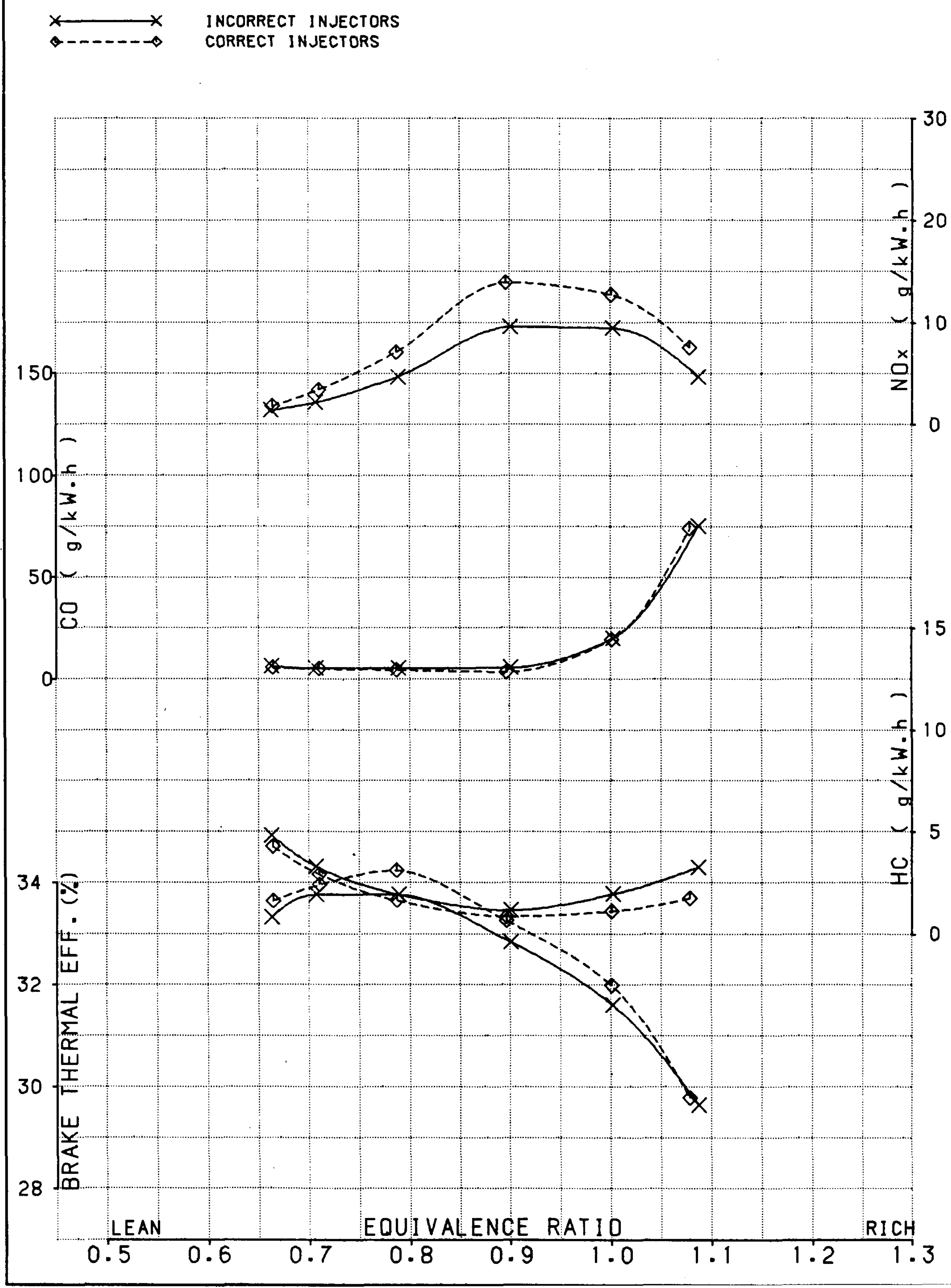
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
MIXTURE LOOP AT 60 REV/SEC 5.5 BAR BMEP



RICARDO

Fig.No.39
Drg.No.
Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
MIXTURE LOOP AT 60 REV/SEC 7.0 BAR BMEP



RICARDO

Fig.No. 40

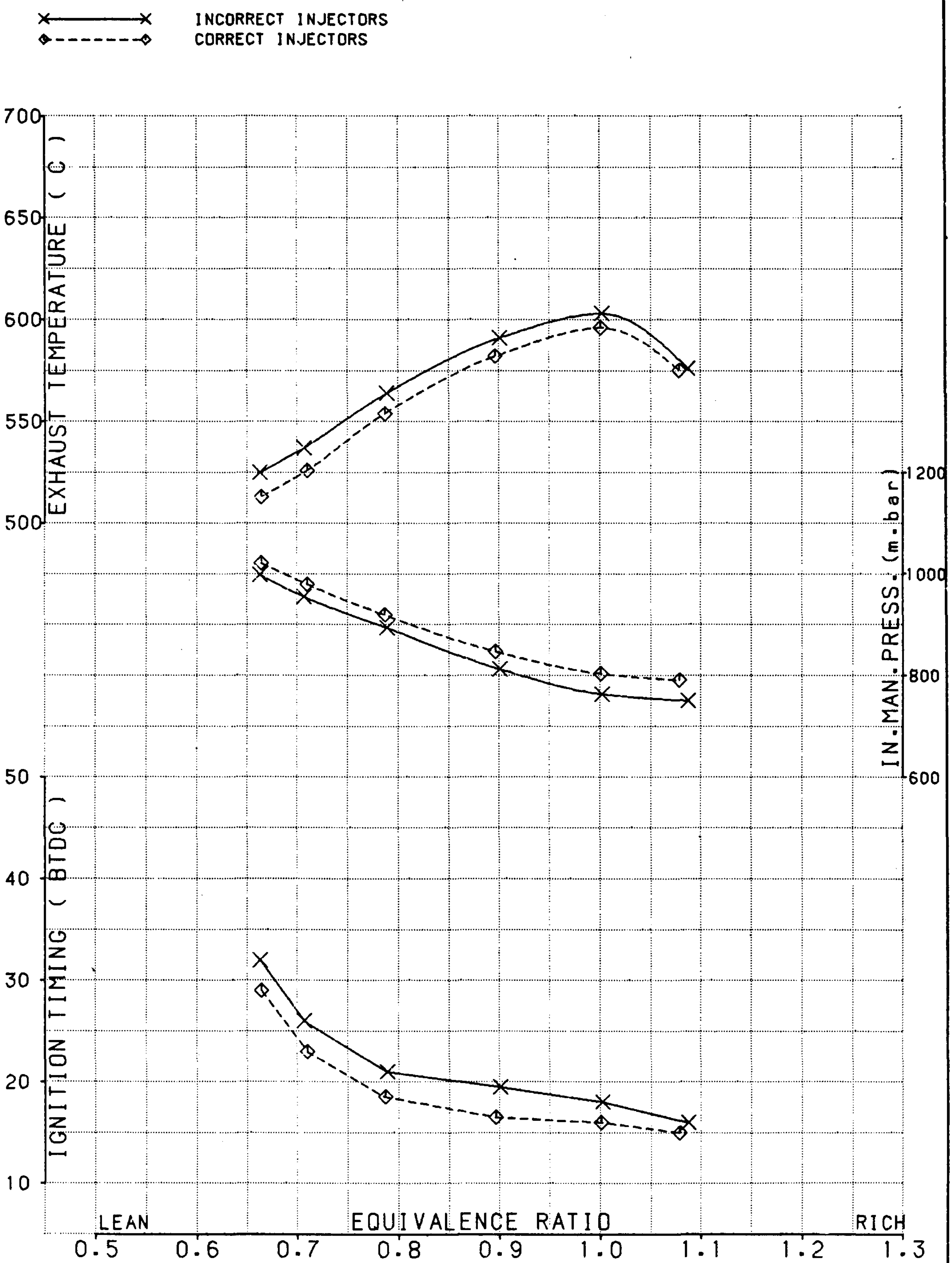
Drg.No.

Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS

MIXTURE LOOP AT 60 REV/SEC 7.0 BAR BMEP



RICARDO

Fig.No.41

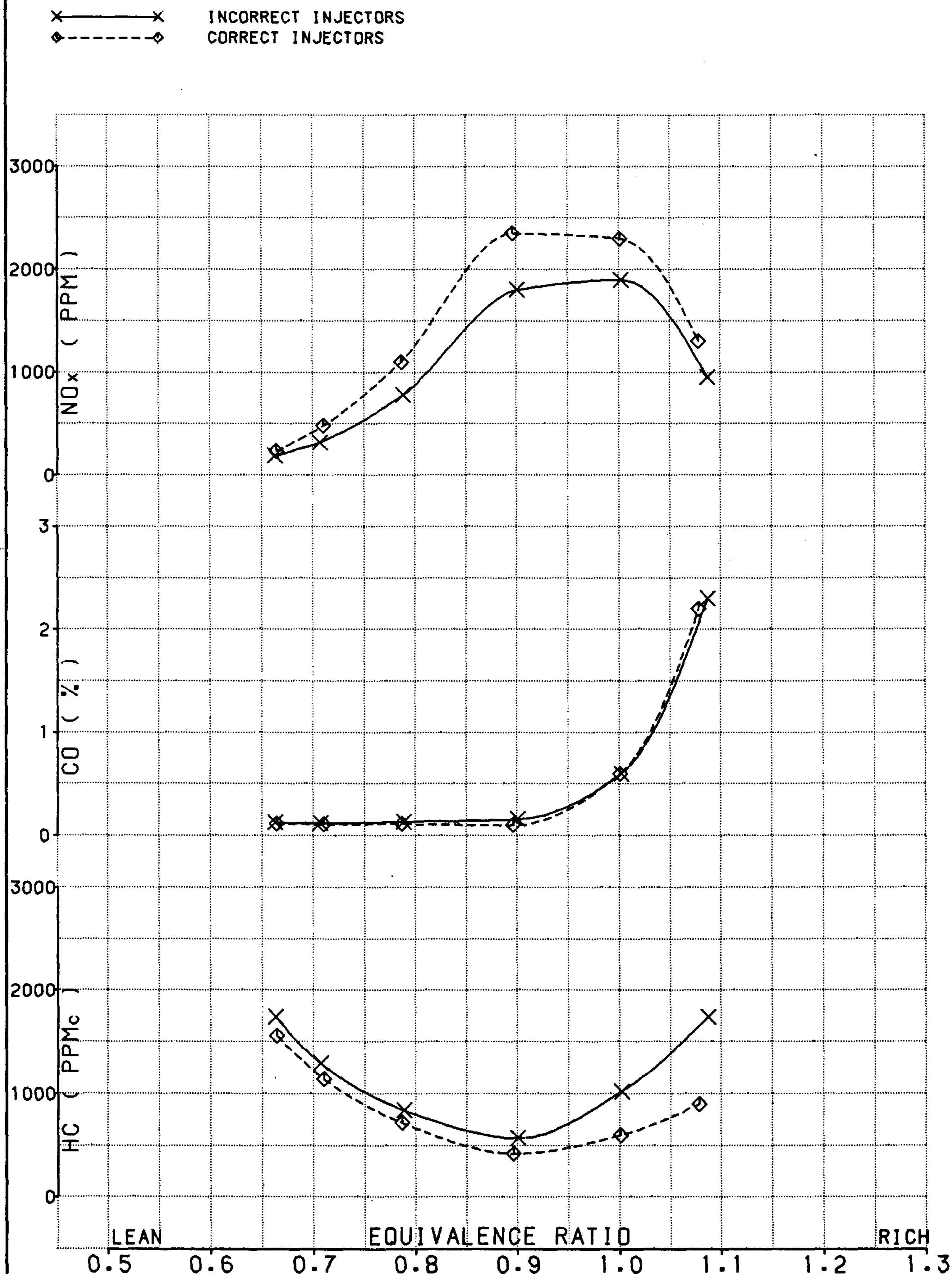
Drg.No.

Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS

MIXTURE LOOP AT 60 REV/SEC 7.0 BAR BMEP



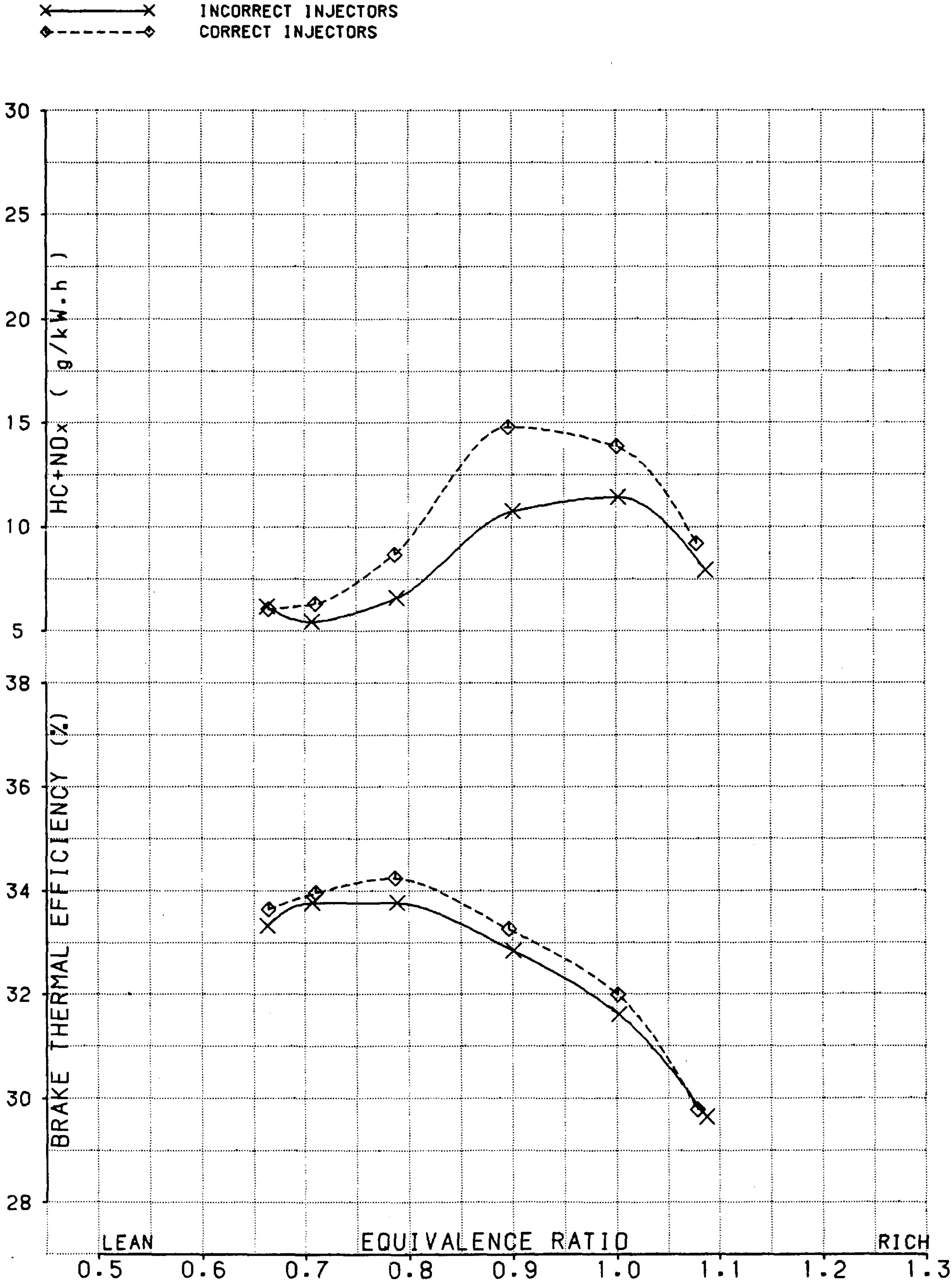
RICARDO

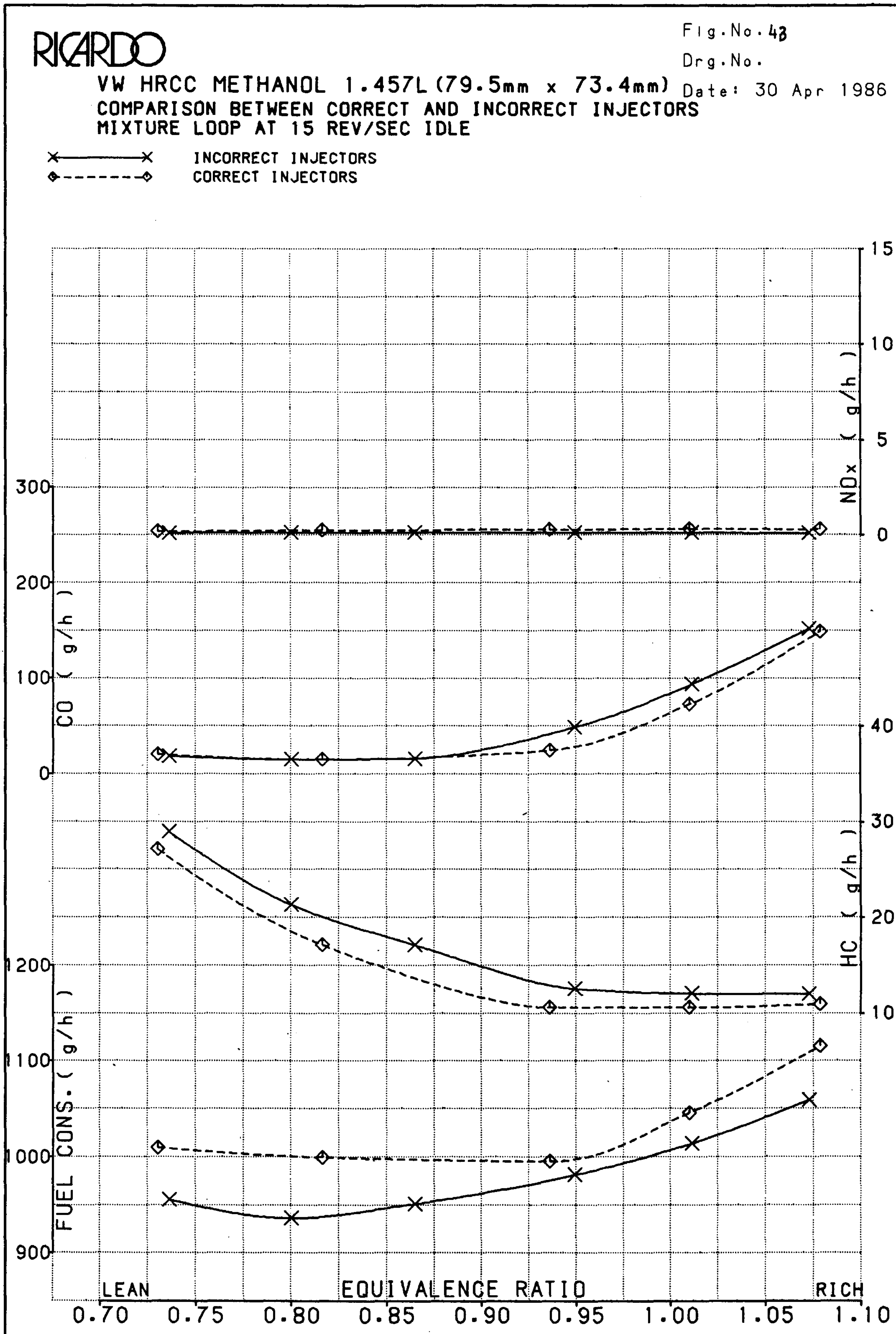
Fig.No. 42

Drg.No.

Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
MIXTURE LOOP AT 60 REV/SEC 7.0 BAR BMEP



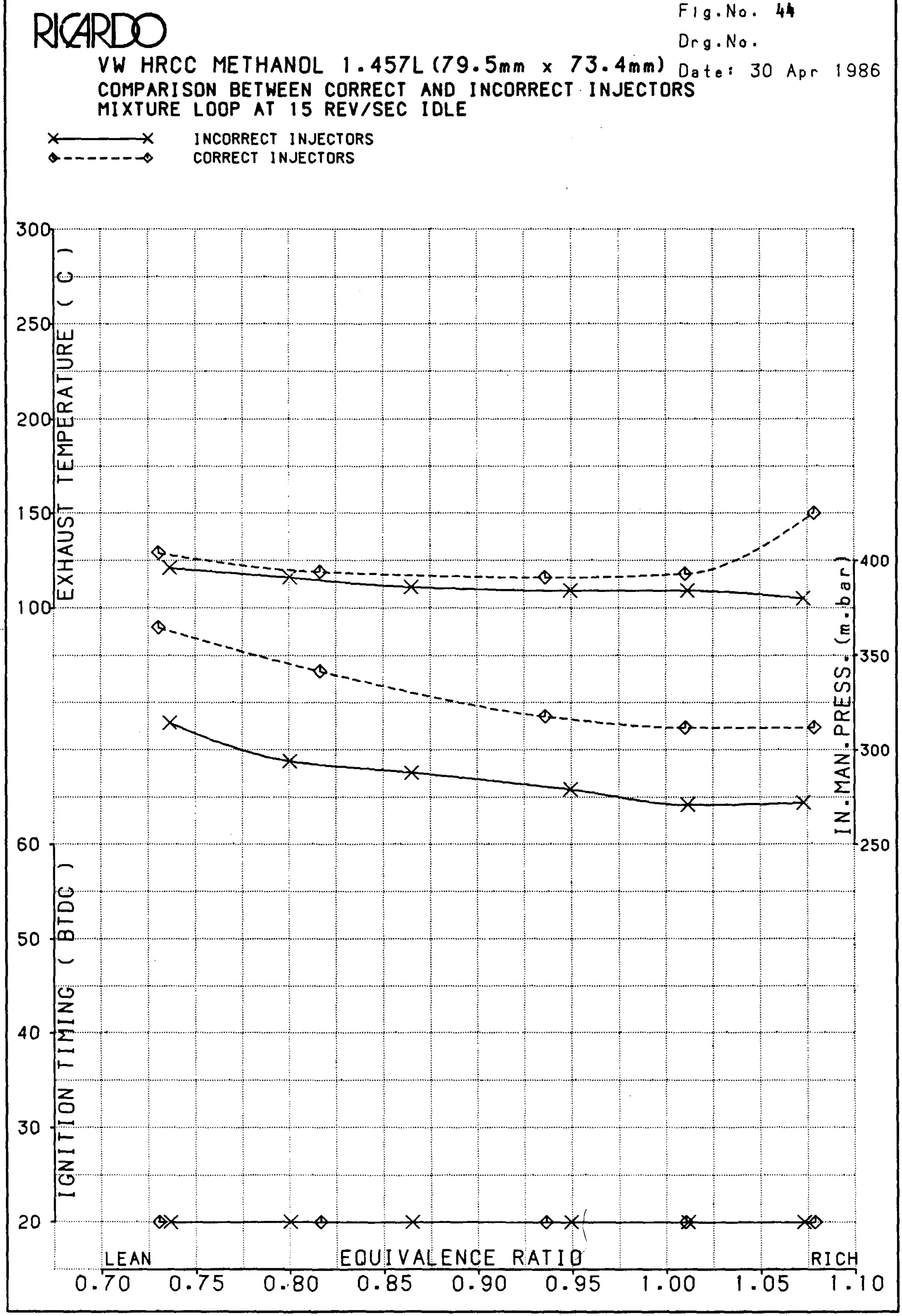


RICARDO
Fig.No.43
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
MIXTURE LOOP AT 15 REV/SEC IDLE
INCORRECT INJECTORS
CORRECT INJECTORS
NOx (g/h)
CO (g/h)
HC (g/h)
FUEL CONS. (g/h)
LEAN
EQUIVALENCE RATIO
RICH
0.70
0.75
0.80
0.85
0.90
0.95
1.00
1.05
1.10

Fig.No. 44

Drg.No.

Date: 30 Apr 1986



RICARDO

Fig.No.45

Drg.No.

Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS

MIXTURE LOOP AT 15 REV/SEC IDLE

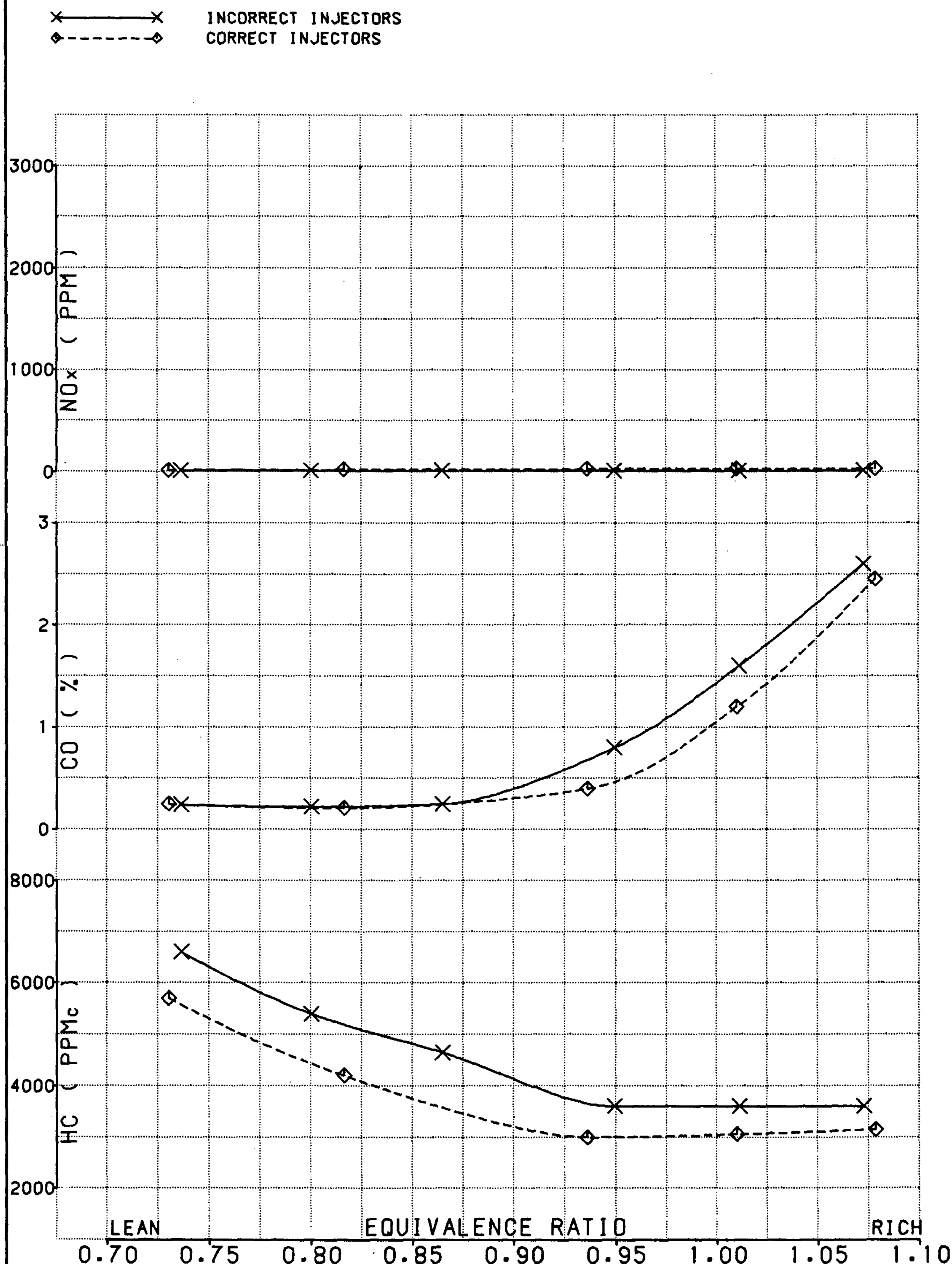
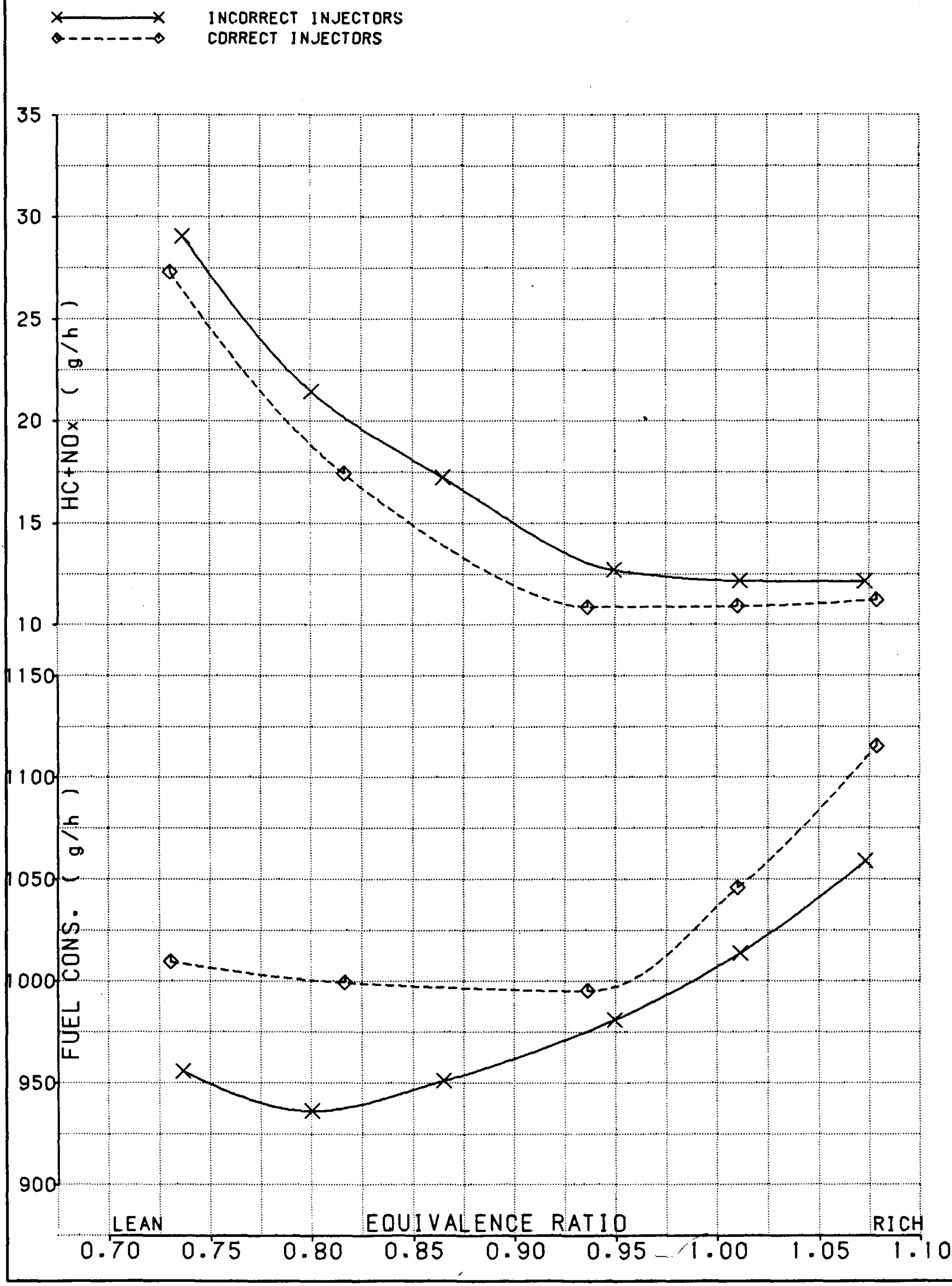


Fig.No. 46
Drg.No.
Date: 30 Apr 1986

RICARDO

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
MIXTURE LOOP AT 15 REV/SEC IDLE



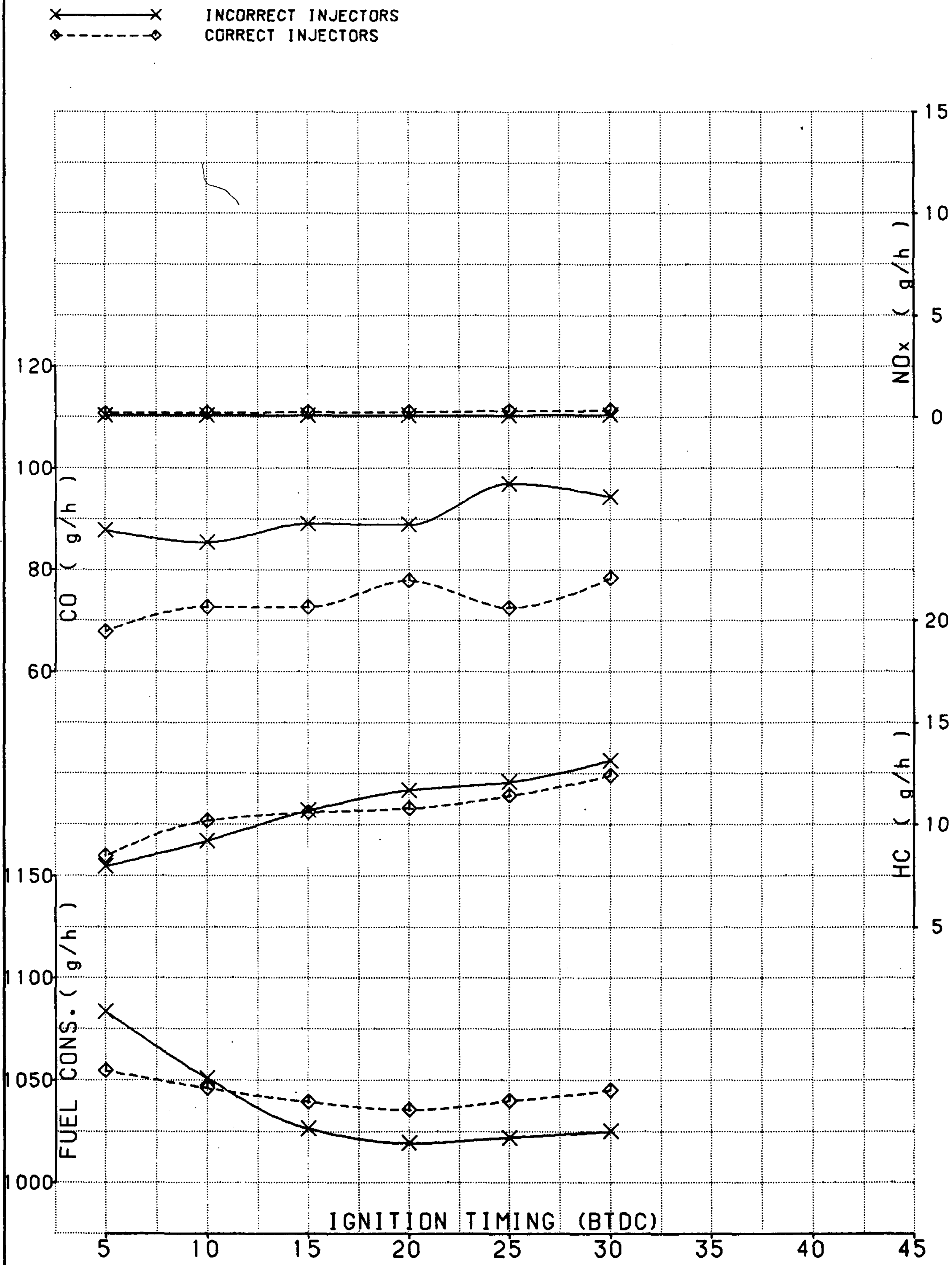
RICARDO

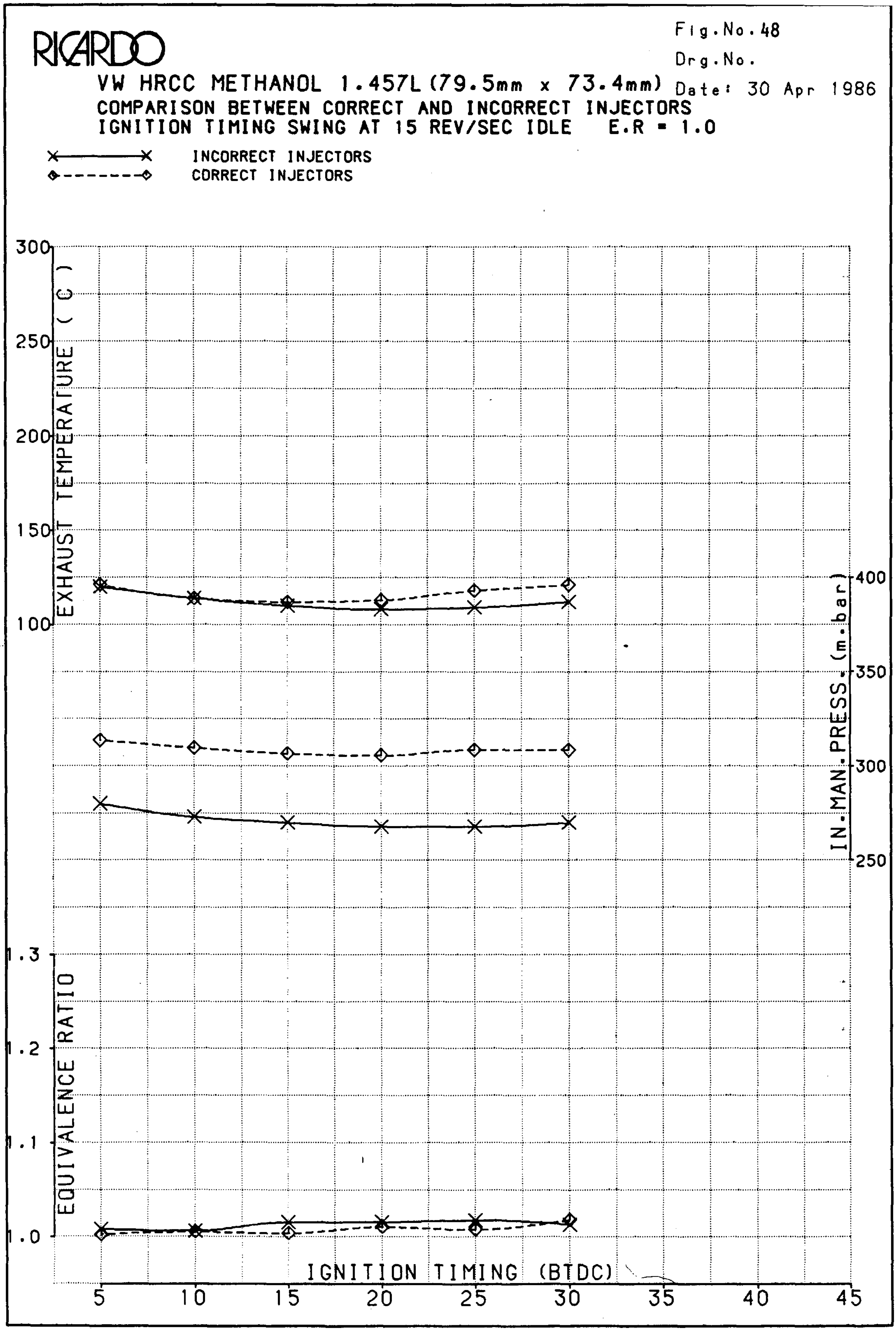
Fig.No. 47

Drg.No.

Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
IGNITION TIMING SWING AT 15 REV/SEC IDLE E.R = 1.0



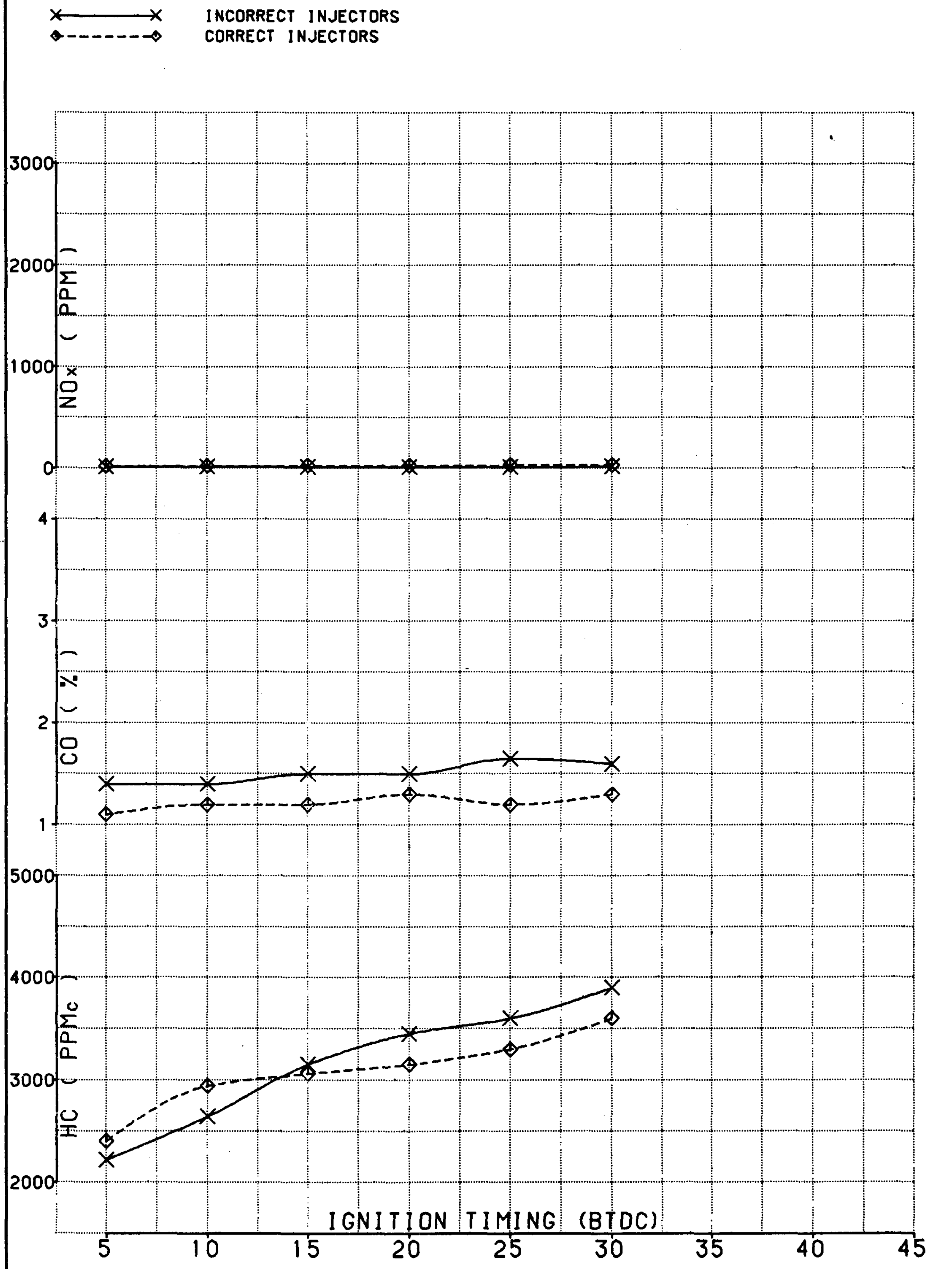


RICARDO
Fig.No.48
Drg.No.
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
Date: 30 Apr 1986
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
IGNITION TIMING SWING AT 15 REV/SEC IDLE E.R = 1.0
INCORRECT INJECTORS
CORRECT INJECTORS
EXHAUST TEMPERATURE (C)
300
250
200
150
100
IN.MAN.PRESS. (m.bar)
400
350
300
250
EQUIVALENCE RATIO
1.3
1.2
1.1
1.0
IGNITION TIMING (BTDC)
5
10
15
20
25
30
35
40
45

RICARDO

Fig.No. 49
Drg.No.
Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
IGNITION TIMING SWING AT 15 REV/SEC IDLE E.R = 1.0



RICARDO

Fig.No. 50

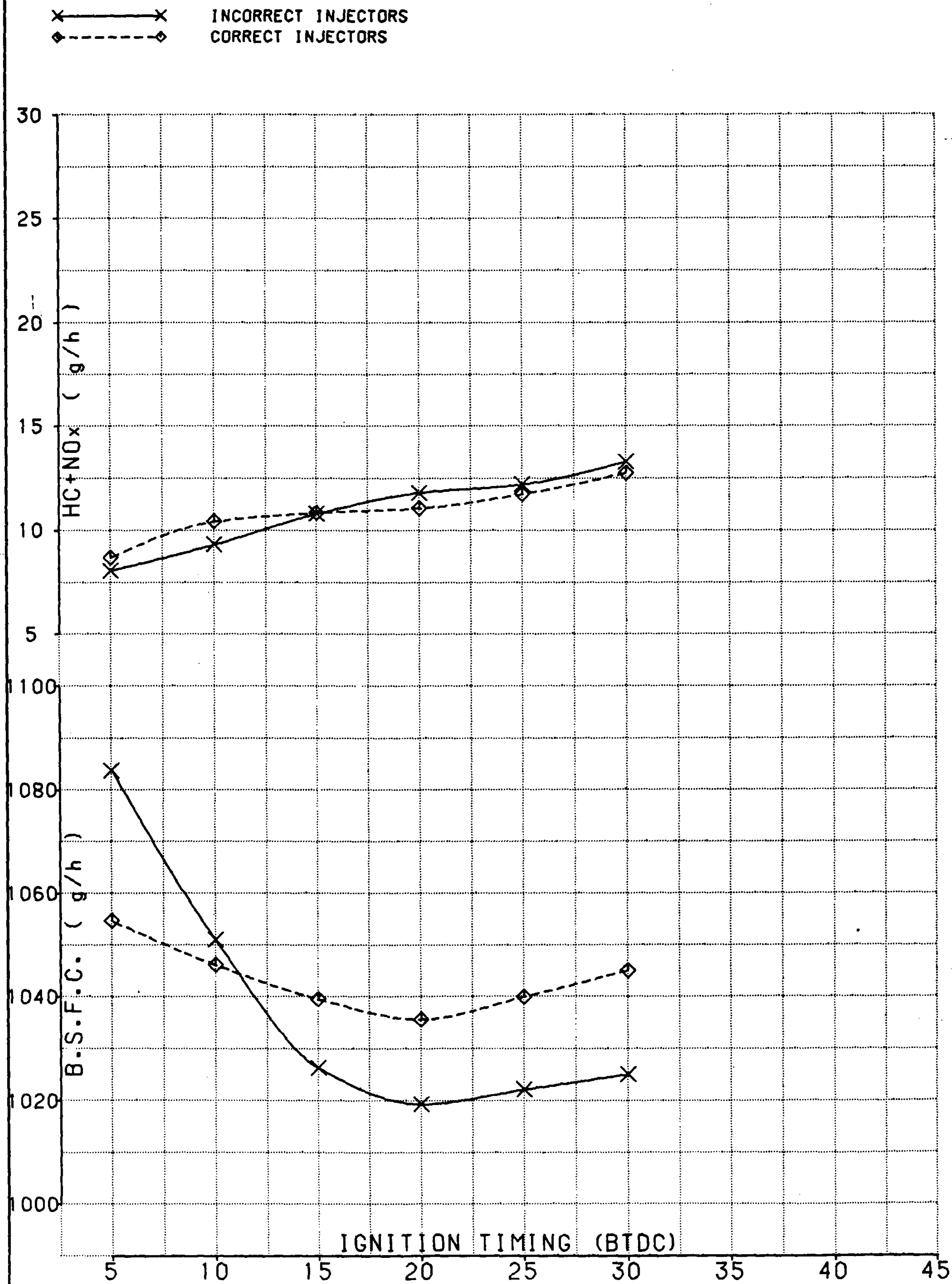
Drg.No.

Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS

IGNITION TIMING SWING AT 15 REV/SEC IDLE E.R = 1.0



RICARDO

Fig.No.51

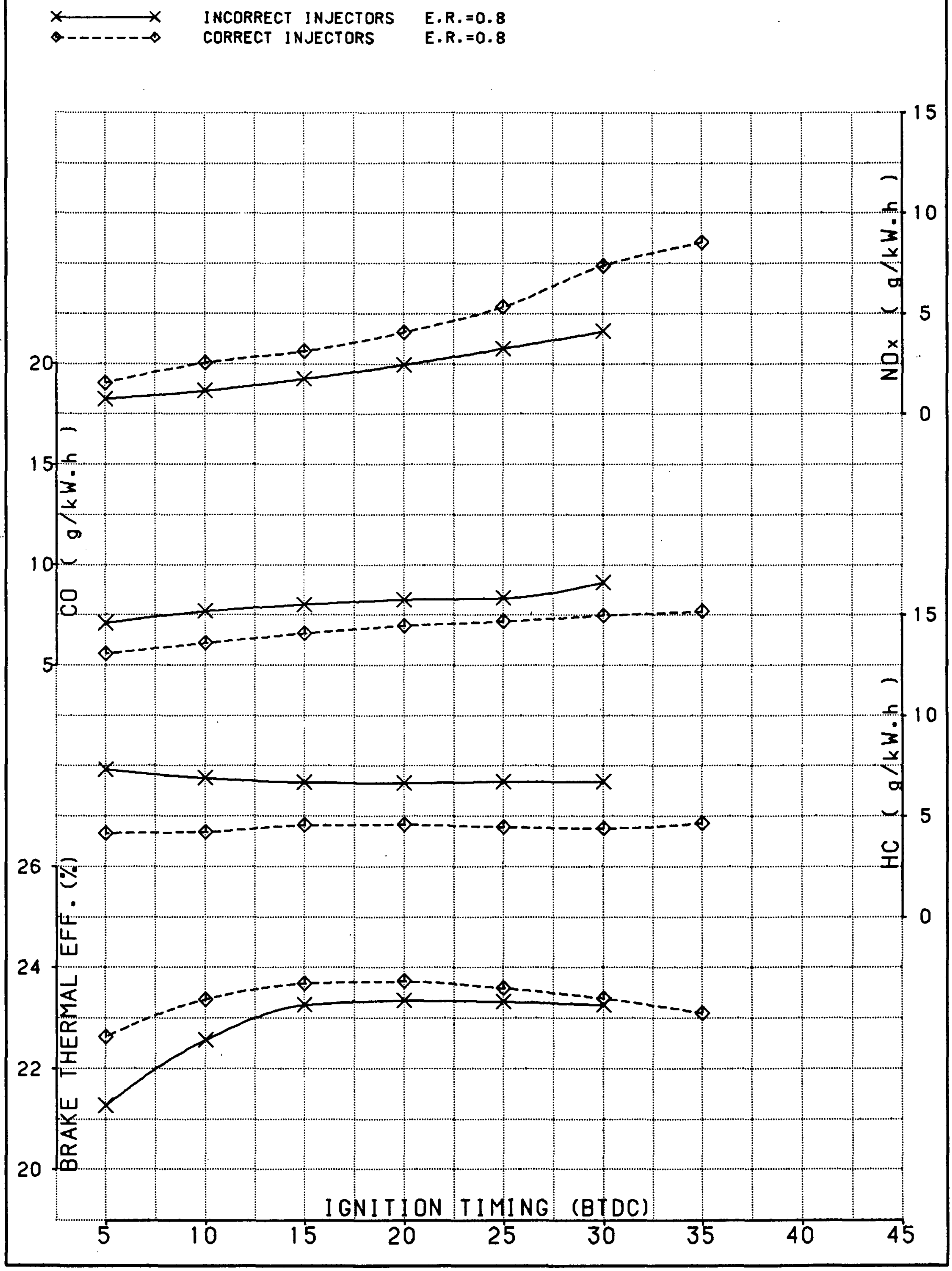
Drg.No.

Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS

IGNITION TIMING SWING AT 40 REV/SEC 2.5 BAR BMEP



RICARDO

Fig.No. 52

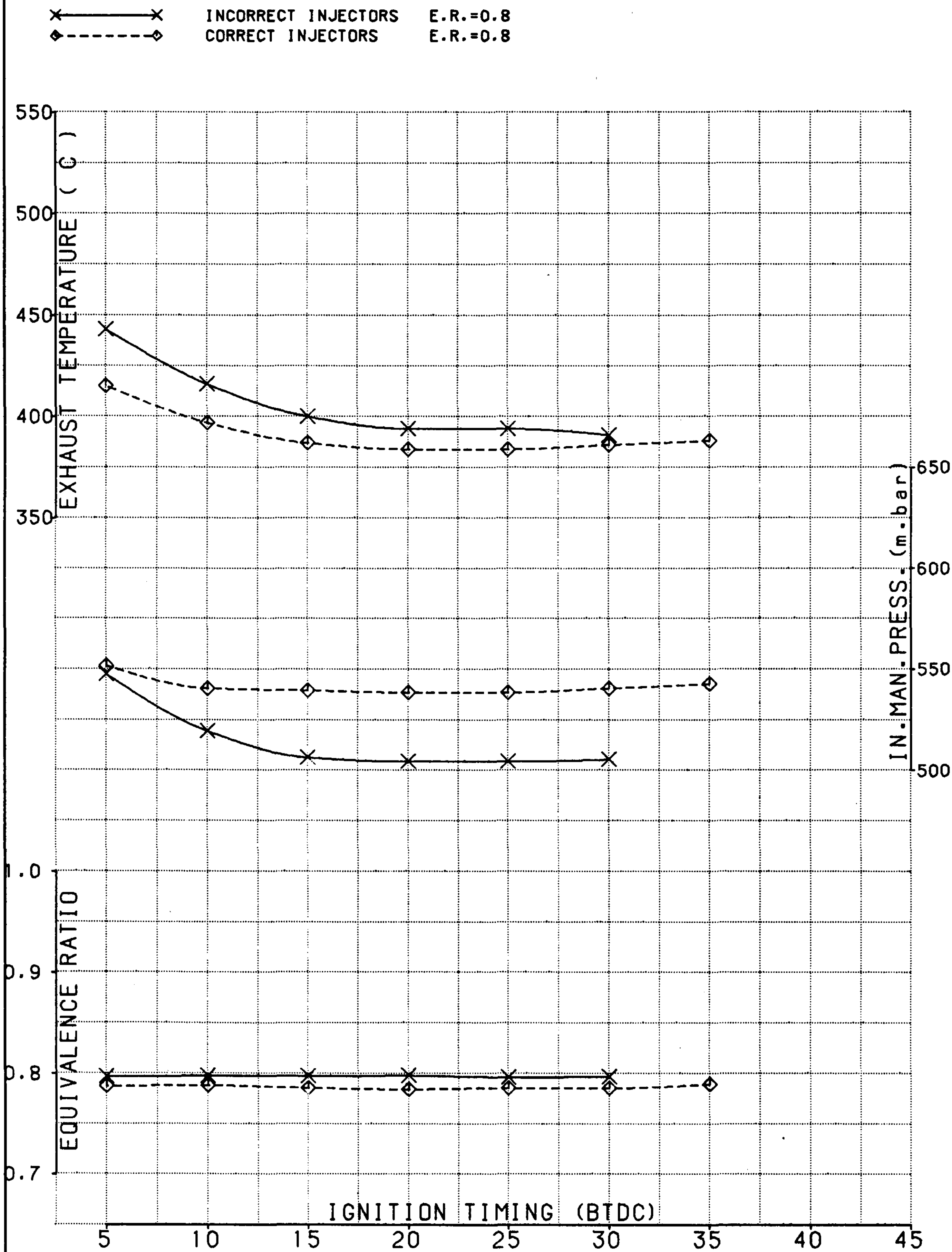
Drg.No.

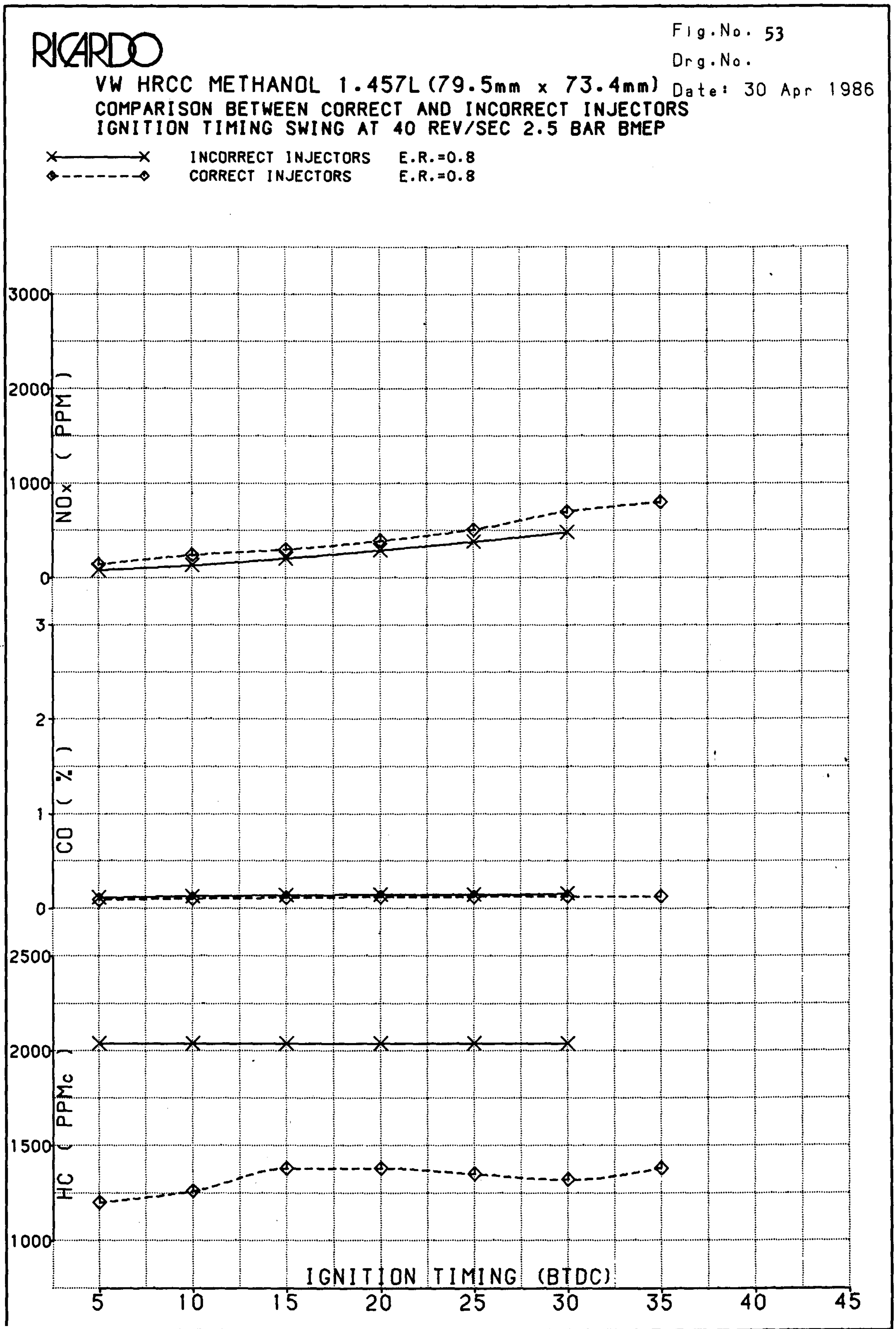
Date: 30 Apr 1986

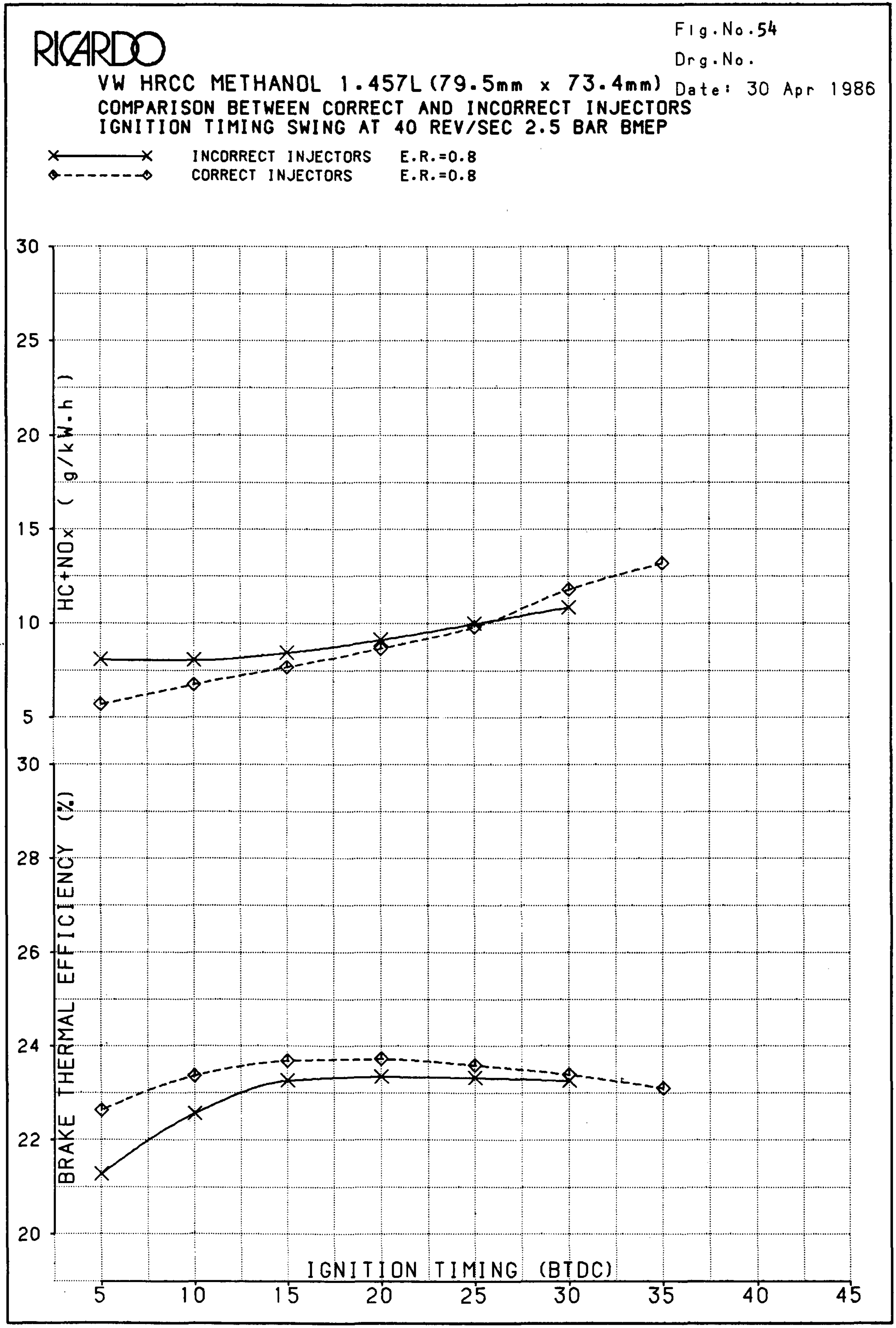
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS

IGNITION TIMING SWING AT 40 REV/SEC 2.5 BAR BMEP




RICARDO
Fig.No. 53
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
IGNITION TIMING SWING AT 40 REV/SEC 2.5 BAR BMEP
INCORRECT INJECTORS E.R.=0.8
CORRECT INJECTORS E.R.=0.8
NOx (PPM)
3000
2000
1000
0
CO (%)
3
2
1
0
HC (PPMc)
2500
2000
1500
1000
IGNITION TIMING (BTDC)
5
10
15
20
25
30
35
40
45



RICARDO
Fig.No.54
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
IGNITION TIMING SWING AT 40 REV/SEC 2.5 BAR BMEP
INCORRECT INJECTORS E.R.=0.8
CORRECT INJECTORS E.R.=0.8
HC+NOx (g/kW.h)
BRAKE THERMAL EFFICIENCY (%)
IGNITION TIMING (BTDC)
5
10
15
20
25
30
20
22
24
26
28
35
40
45

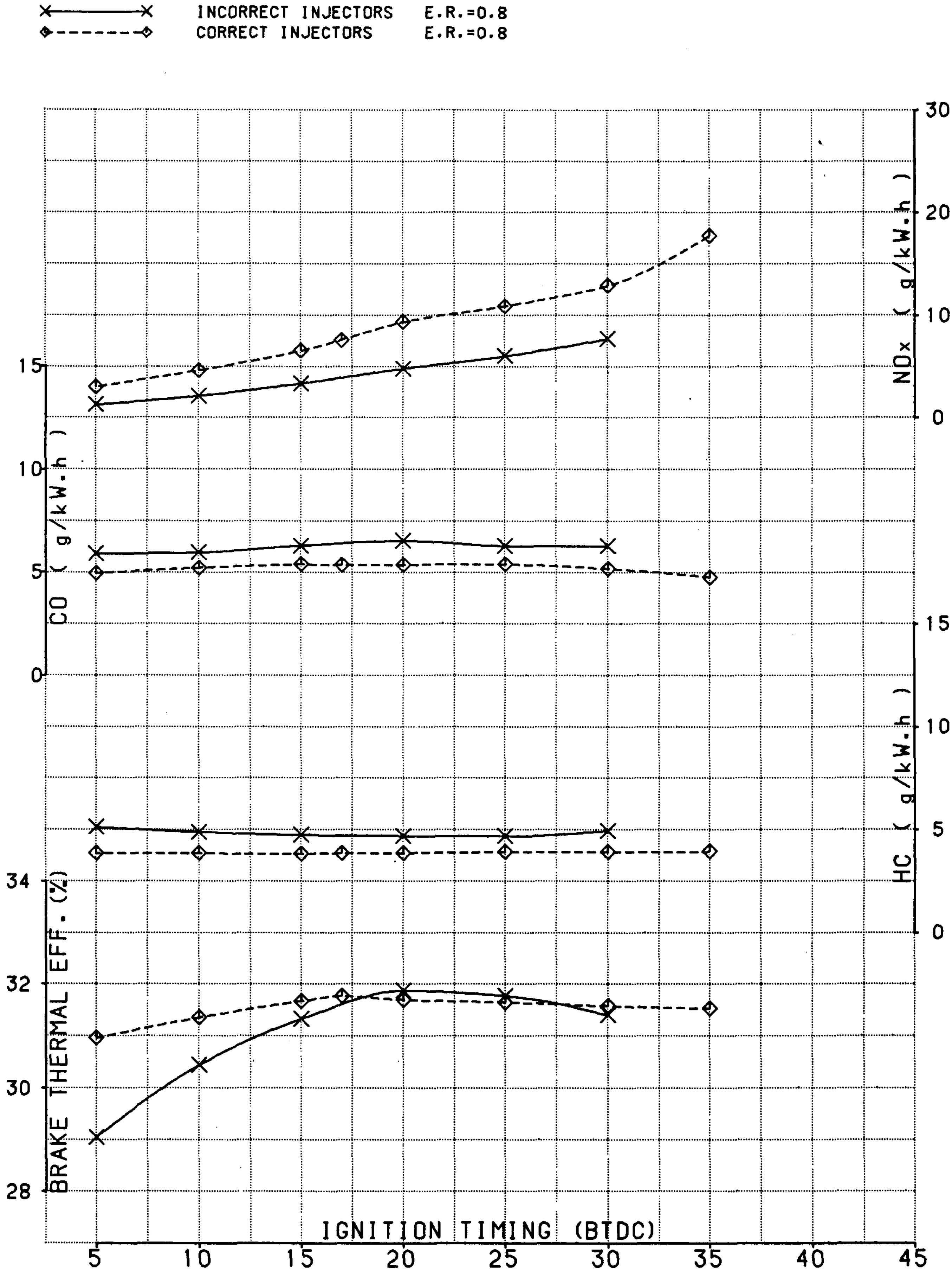
RICARDO

Fig.No. 55

Drg.No.

Date: 30 Apr 1986

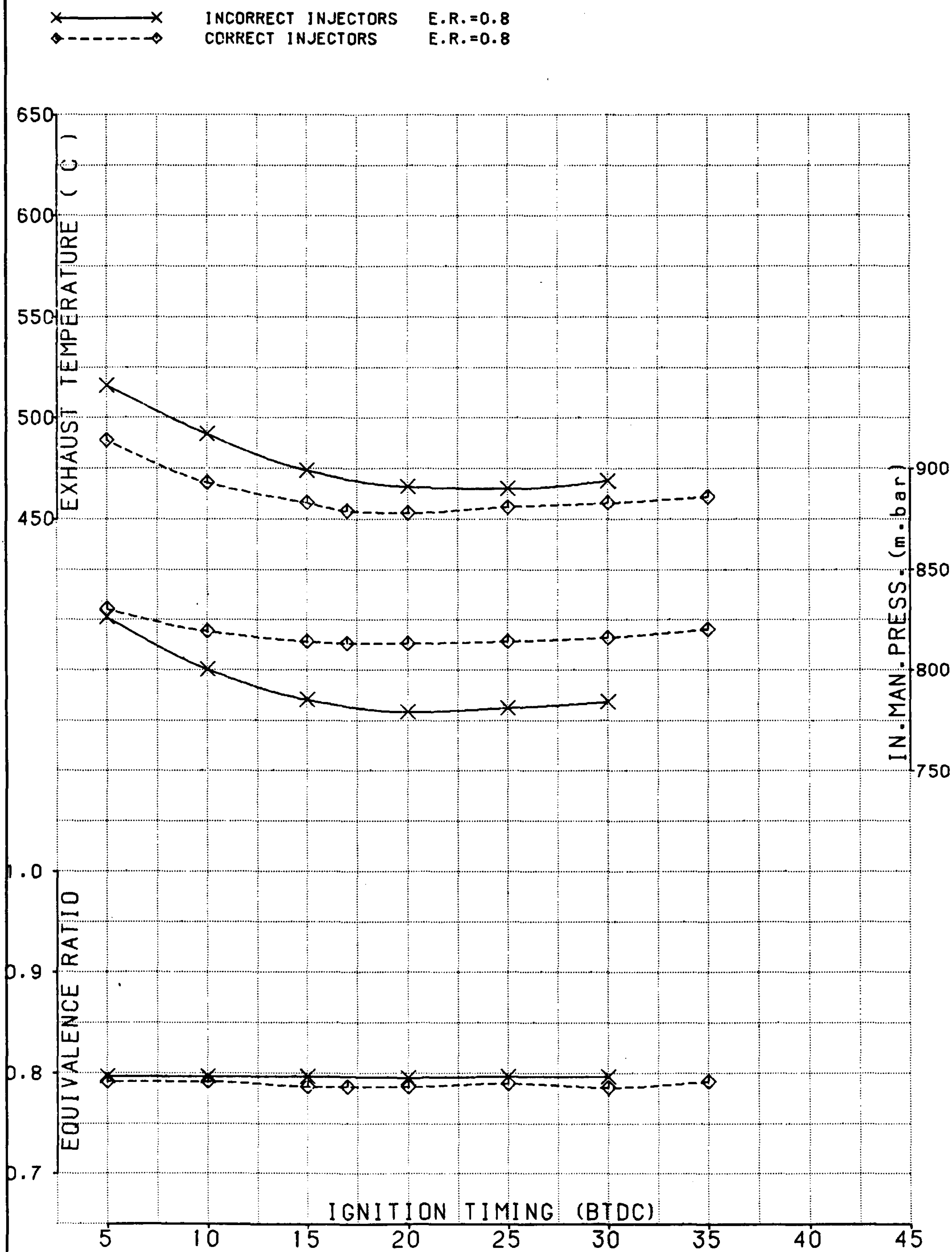
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
IGNITION TIMING SWING AT 40 REV/SEC 5.5 BAR BMEP

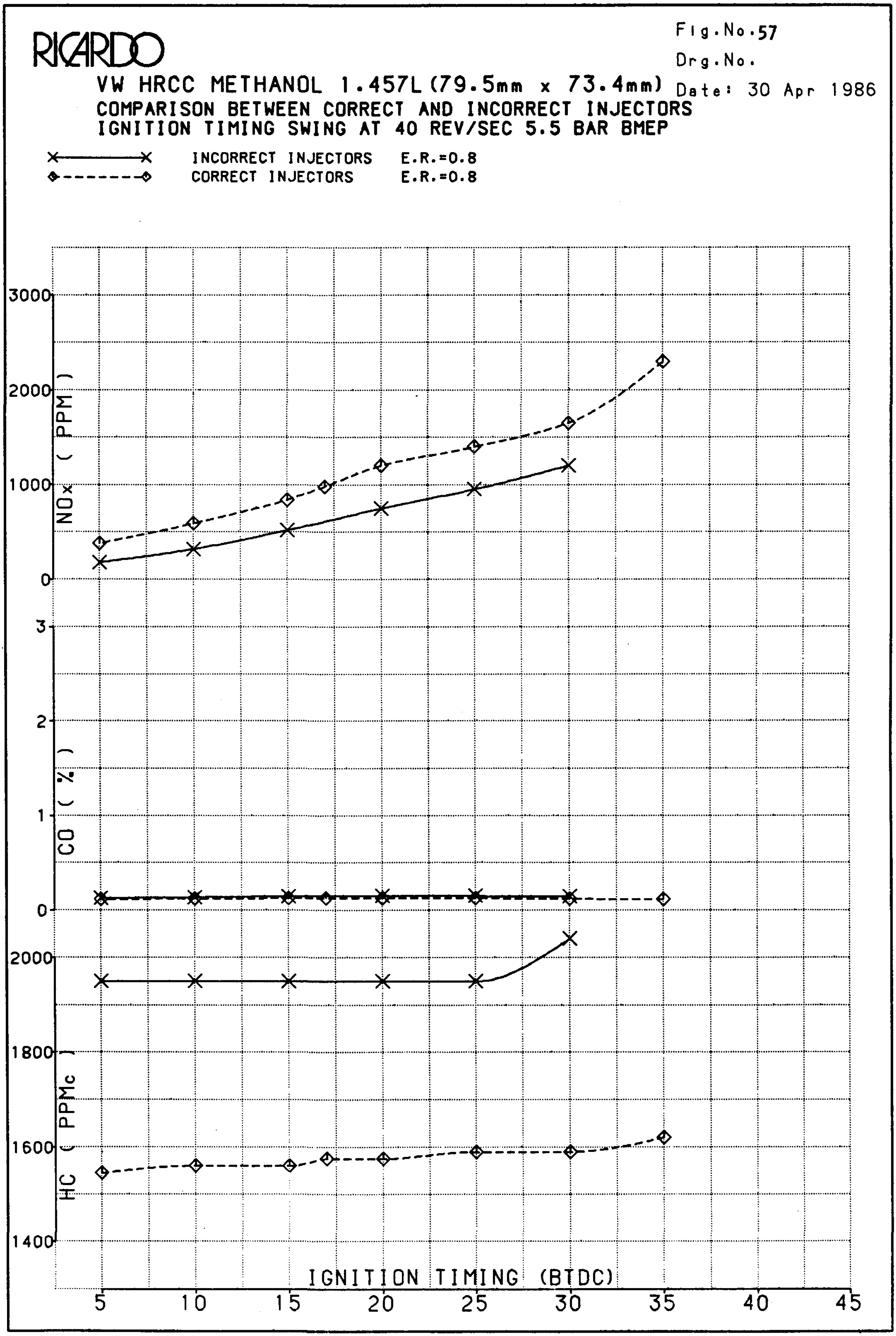


RICARDO

Fig.No. 56
Drg.No.
Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
IGNITION TIMING SWING AT 40 REV/SEC 5.5 BAR BMEP





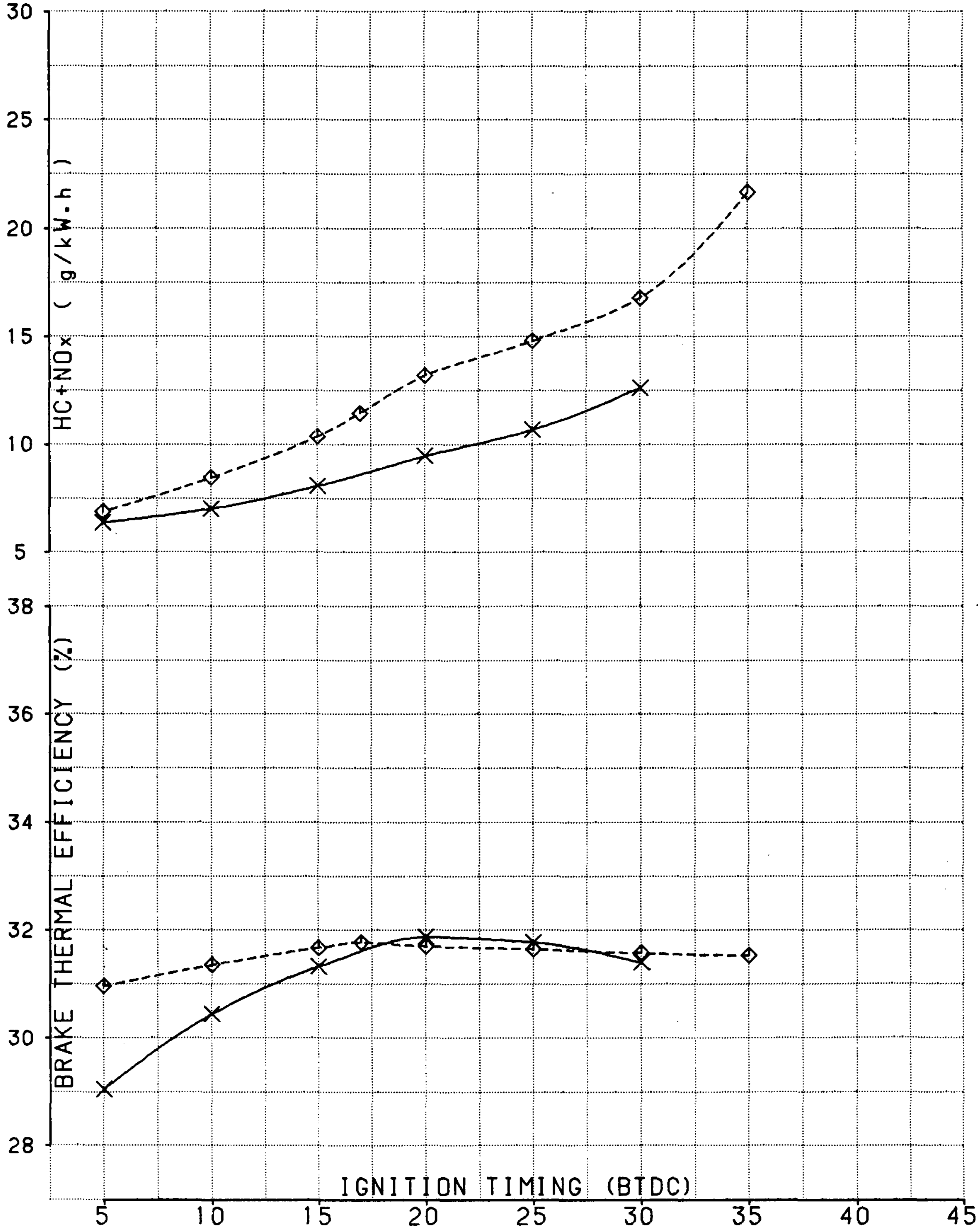
RICARDO
Fig.No.57
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
IGNITION TIMING SWING AT 40 REV/SEC 5.5 BAR BMEP
INCORRECT INJECTORS E.R.=0.8
CORRECT INJECTORS E.R.=0.8
NOx (PPM)
3000
2000
1000
0
CO (%)
3
2
1
0
HC (PPMc)
2000
1800
1600
1400
IGNITION TIMING (BTDC)
5
10
15
20
25
30
35
40
45

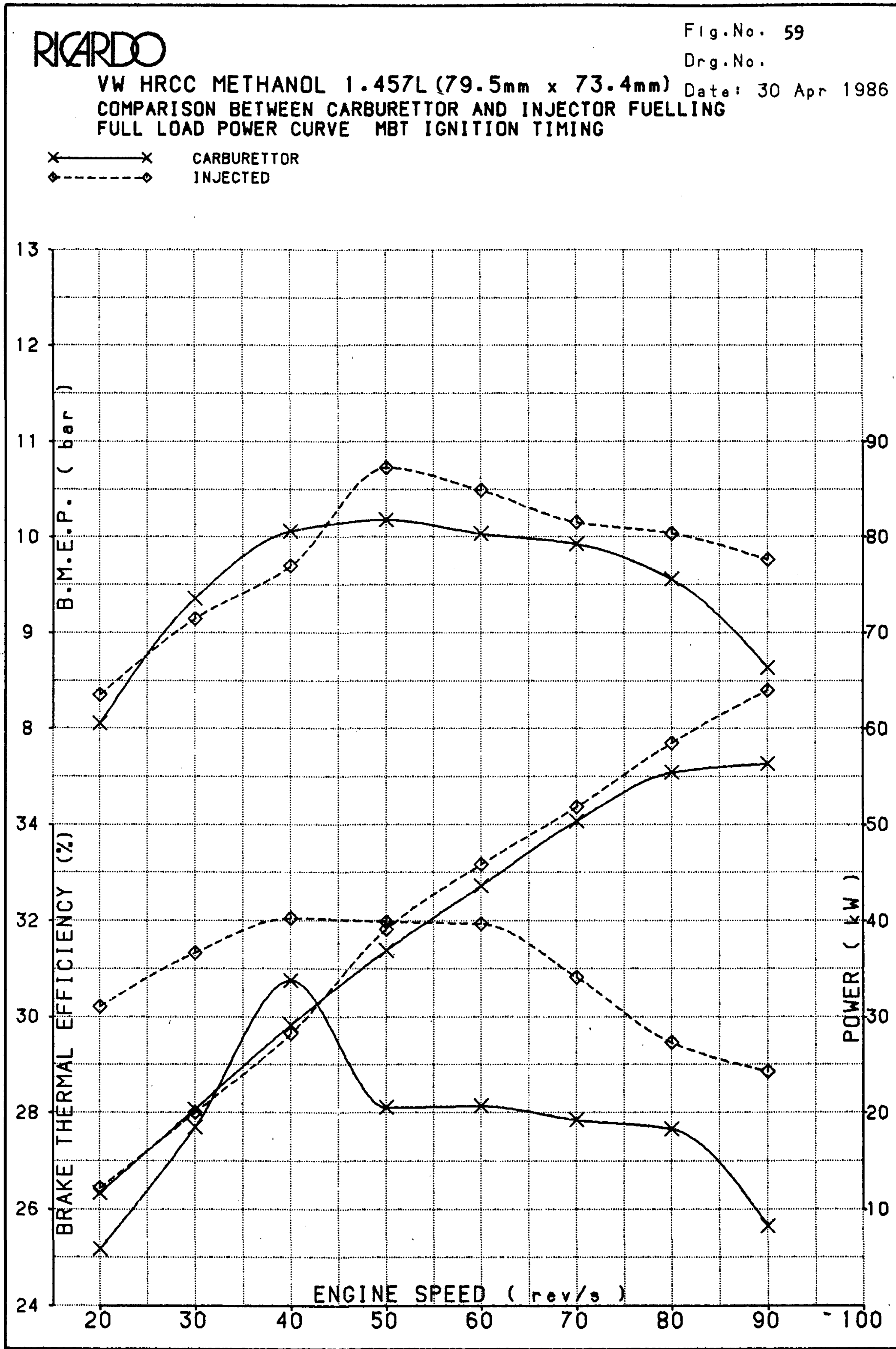
RICARDO

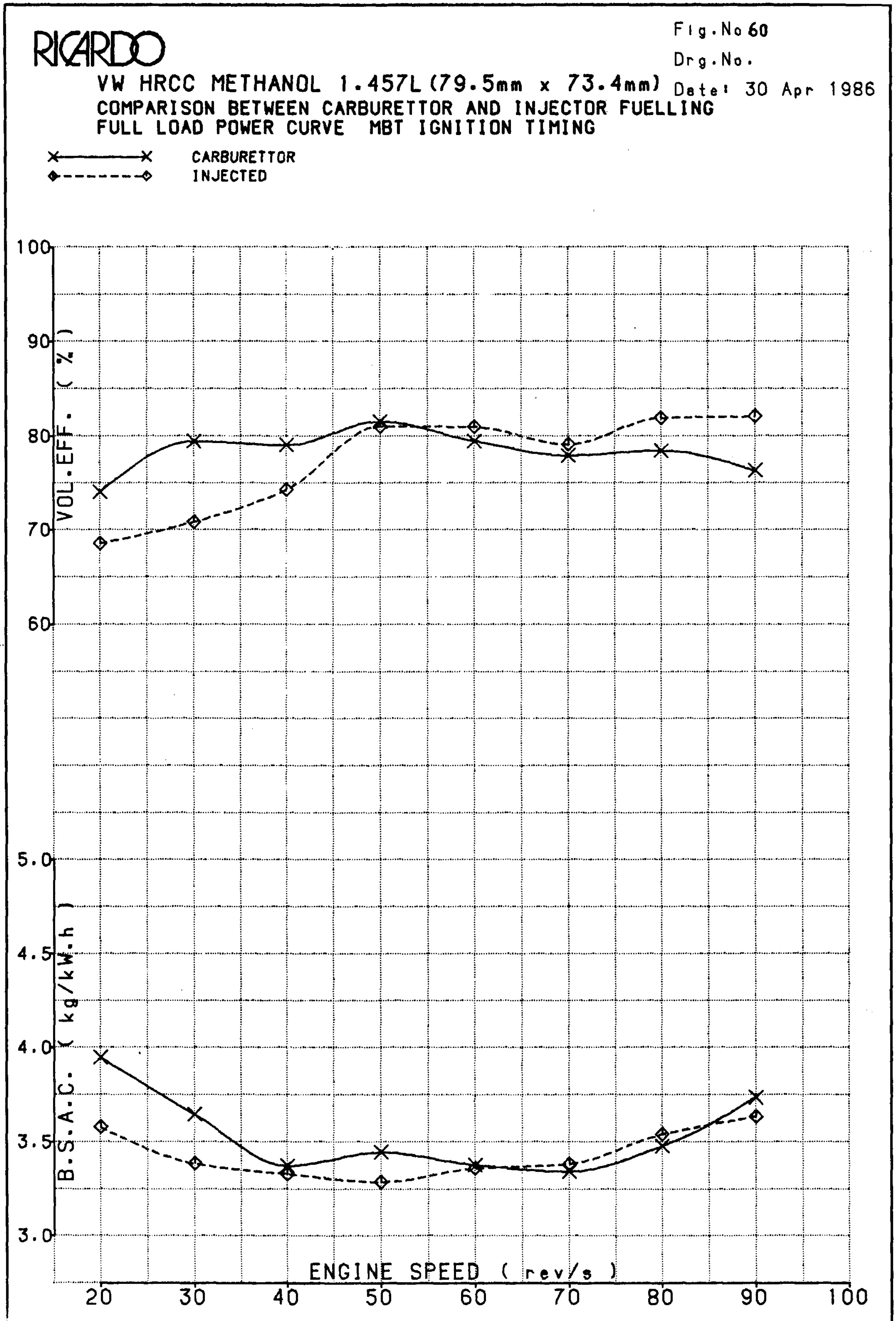
Fig.No. 58
Drg.No.
Date: 30 Apr 1986

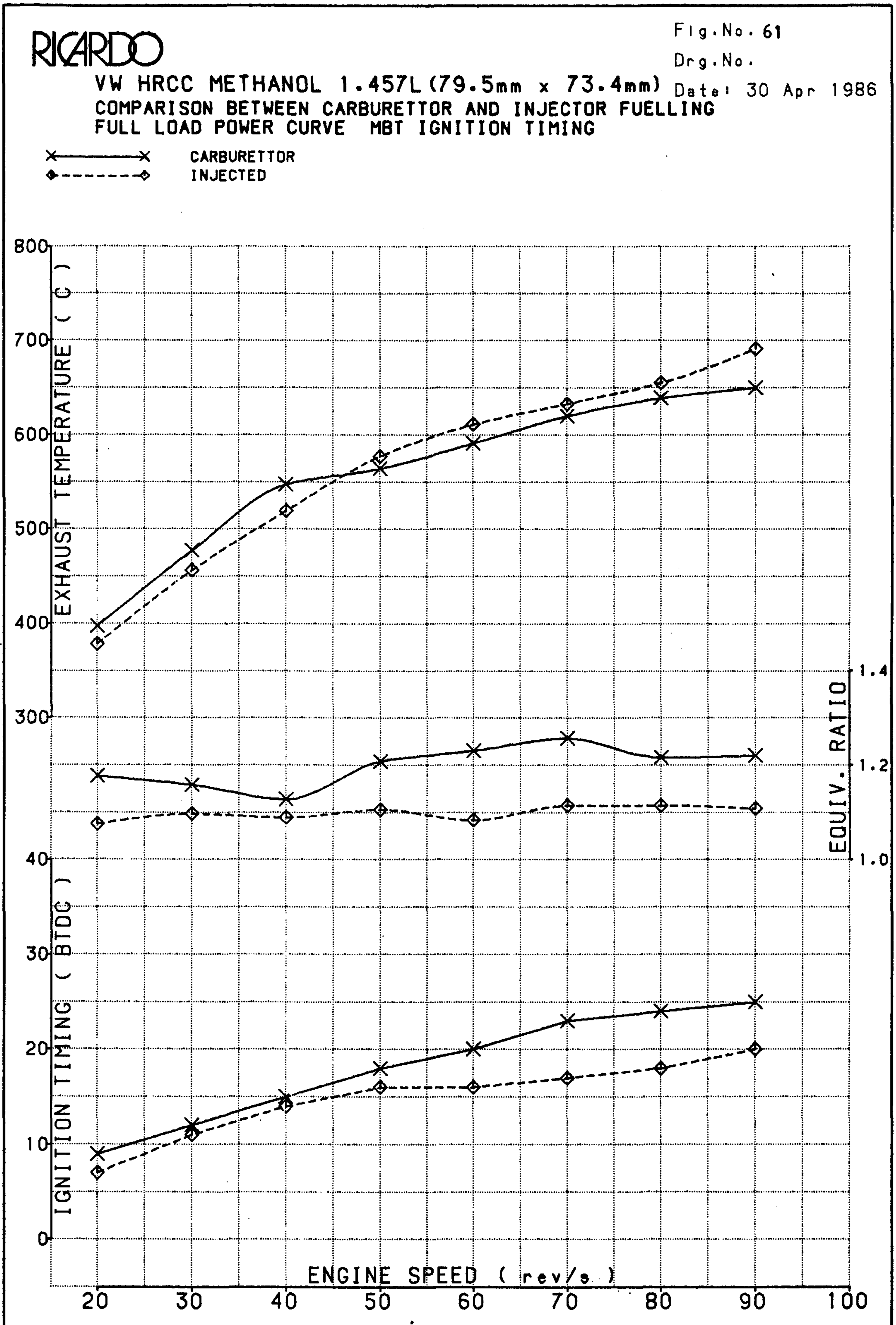
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CORRECT AND INCORRECT INJECTORS
IGNITION TIMING SWING AT 40 REV/SEC 5.5 BAR BMEP

X———X INCORRECT INJECTORS E.R.=0.8
◇- - - -◇ CORRECT INJECTORS E.R.=0.8




RICARDO
Fig.No. 59
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CARBURETTOR AND INJECTOR FUELLING
FULL LOAD POWER CURVE MBT IGNITION TIMING
CARBURETTOR
INJECTED
B.M.E.P. (bar)
BRAKE THERMAL EFFICIENCY (%)
POWER (kW)
ENGINE SPEED (rev/s)
13
12
11
10
9
8
34
32
30
28
26
24
90
80
70
60
50
40
30
20
10
20
30
40
50
60
70
80
90
100


RICARDO
Fig.No 60
Drg.No.
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
Date: 30 Apr 1986
COMPARISON BETWEEN CARBURETTOR AND INJECTOR FUELLING
FULL LOAD POWER CURVE MBT IGNITION TIMING
CARBURETTOR
INJECTED
VOL.EFF. (%)
100
90
80
70
60
B.S.A.C. (kg/kW.h)
5.0
4.5
4.0
3.5
3.0
ENGINE SPEED (rev/s)
20
30
40
50
60
70
80
90
100


RICARDO
Fig. No. 61
Drg. No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CARBURETTOR AND INJECTOR FUELLING
FULL LOAD POWER CURVE MBT IGNITION TIMING
CARBURETTOR
INJECTED
EXHAUST TEMPERATURE (C)
800
700
600
500
400
300
EQUIV. RATIO
1.4
1.2
1.0
IGNITION TIMING (BTDC)
40
30
20
10
0
ENGINE SPEED (rev/s)
20
30
40
50
60
70
80
90
100

RICARDO

Fig.No. 62

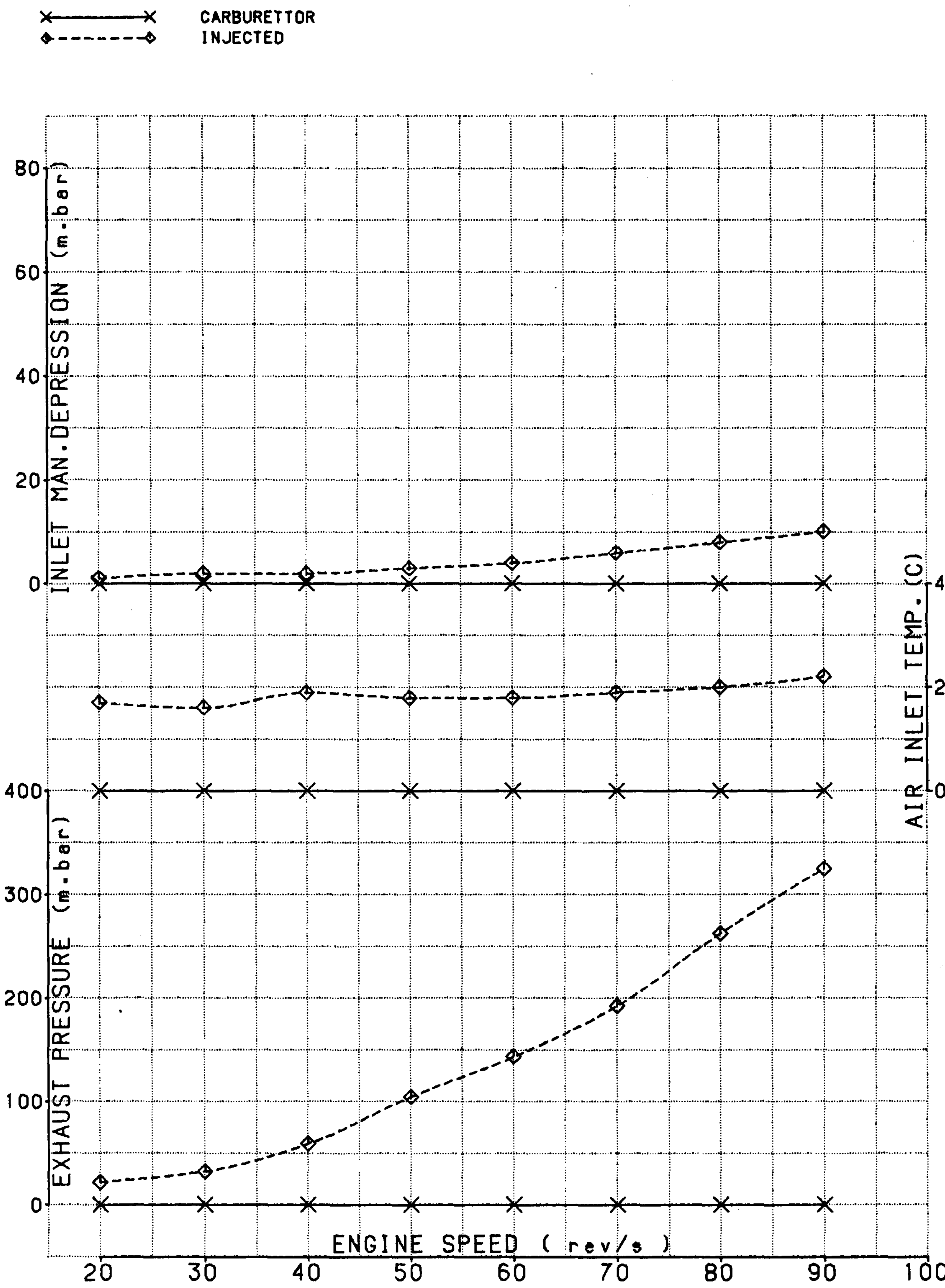
Drg.No.

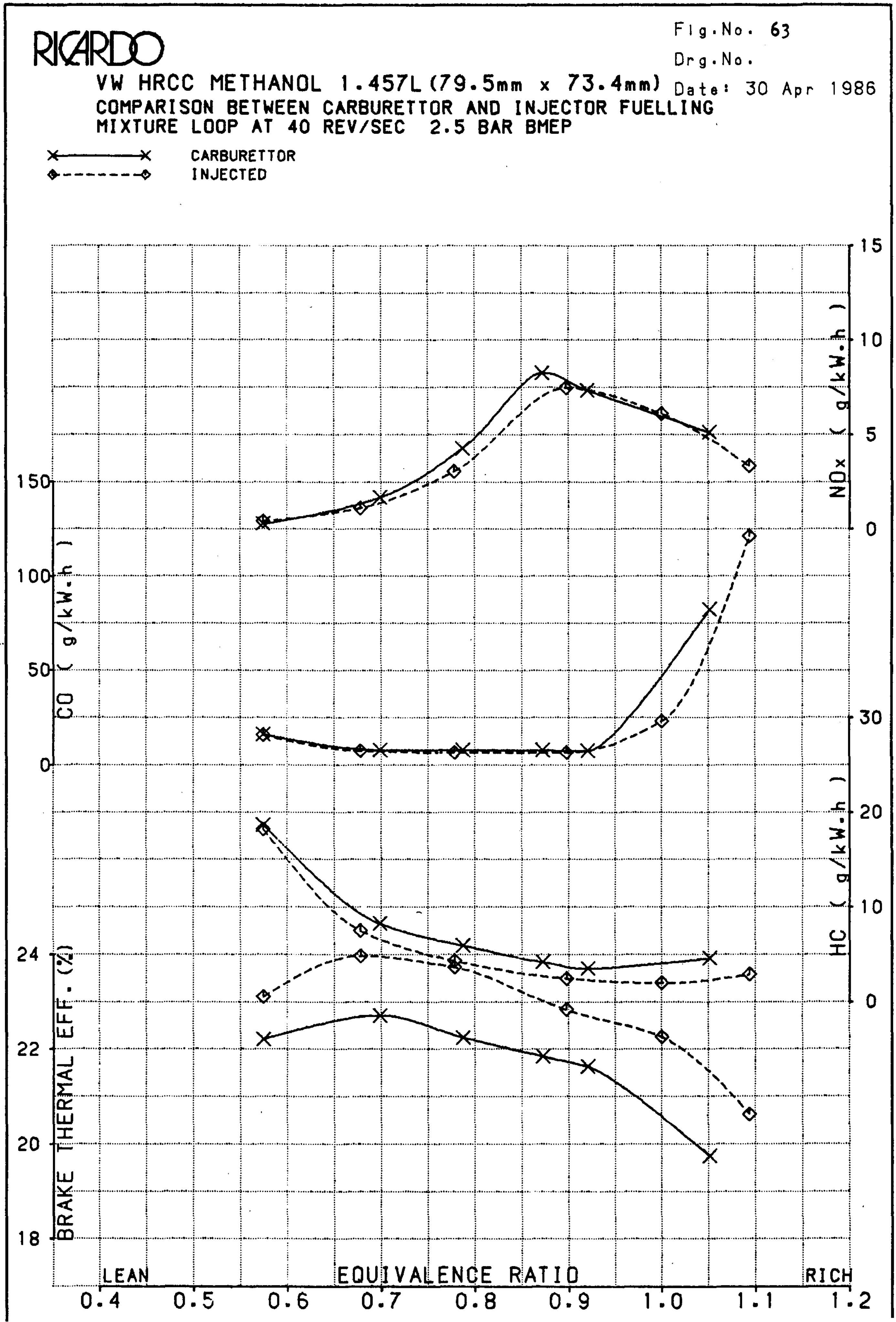
Date: 30 Apr 1986

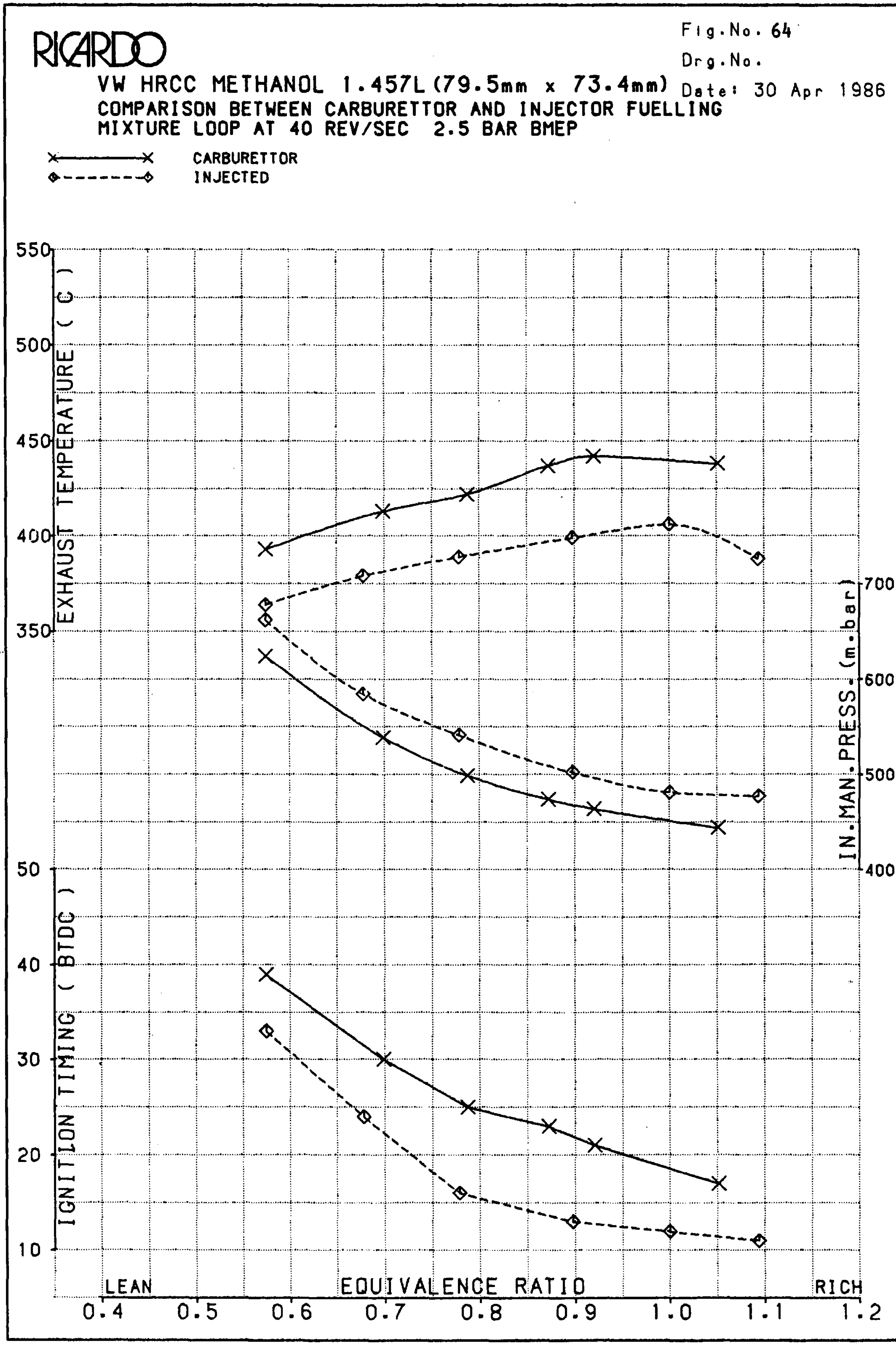
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

COMPARISON BETWEEN CARBURETTOR AND INJECTOR FUELLING

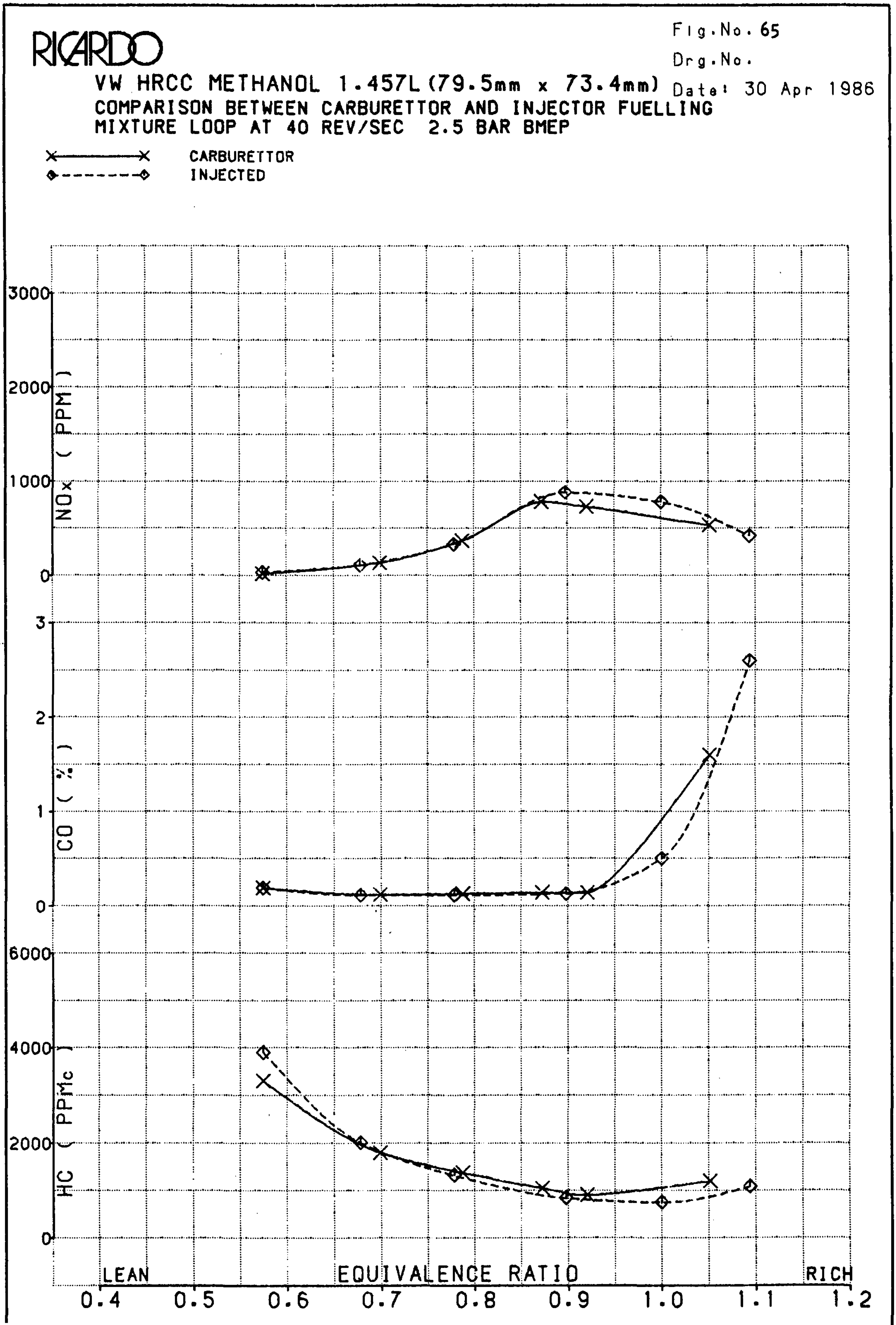
FULL LOAD POWER CURVE MBT IGNITION TIMING

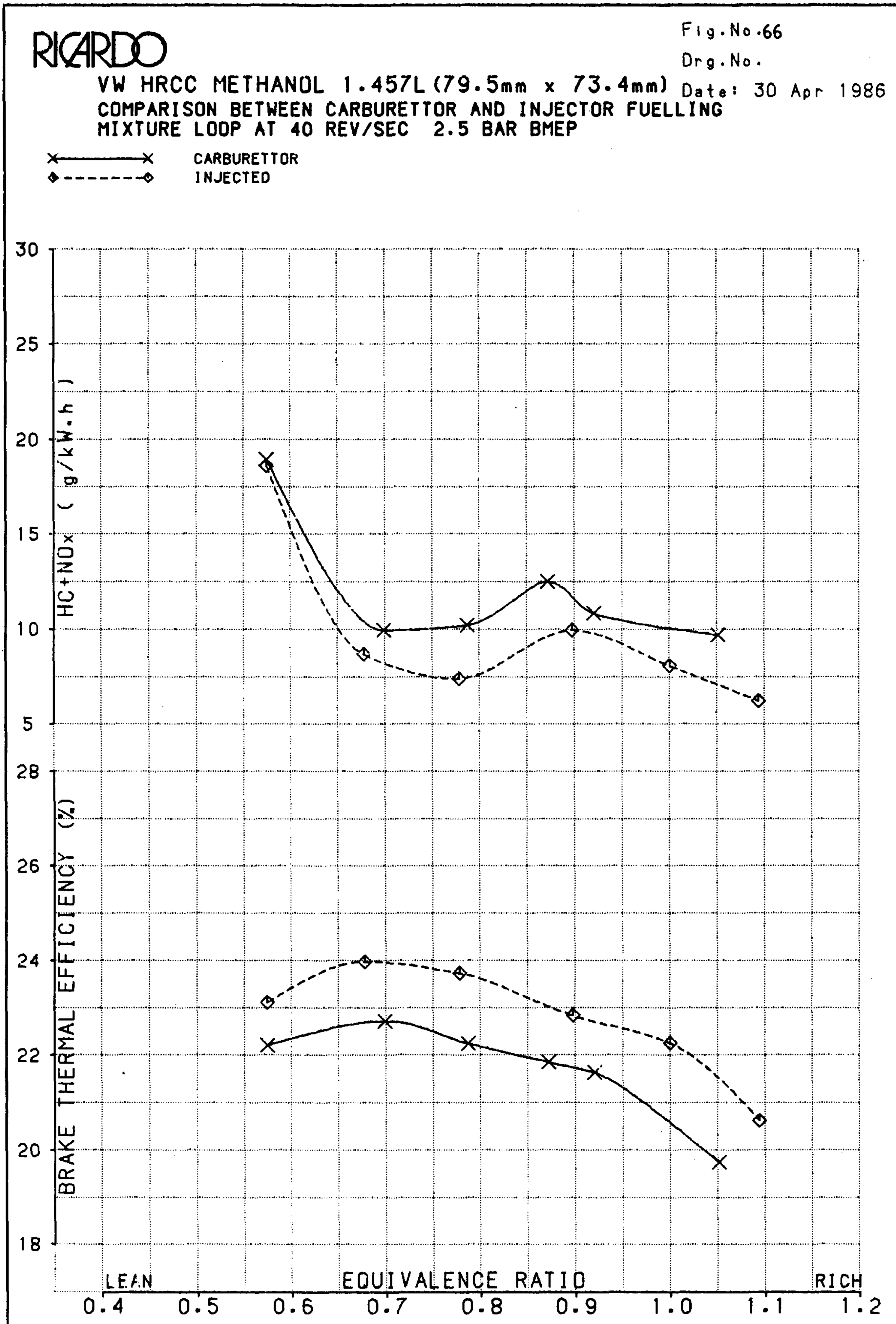


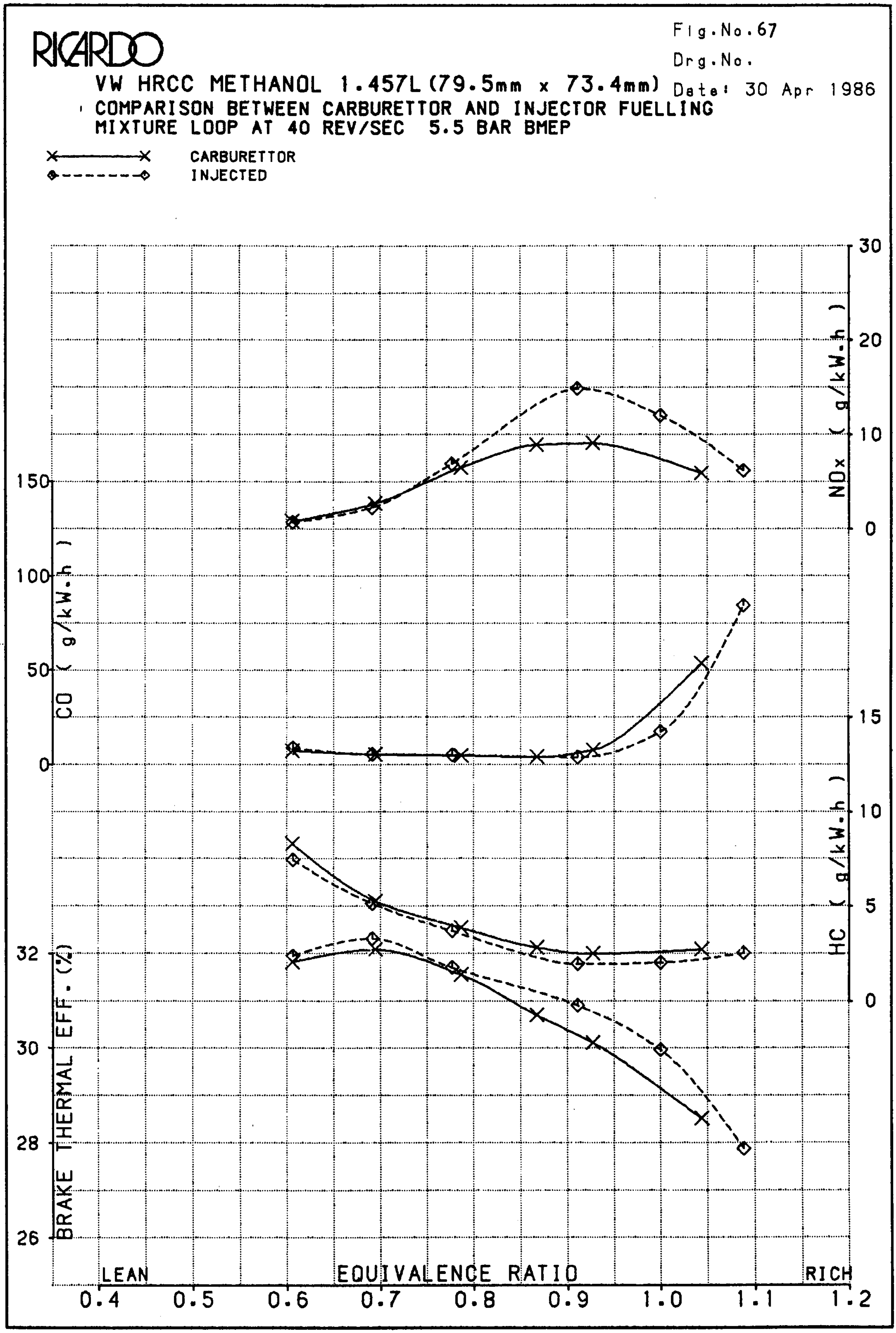

RICARDO
Fig.No. 63
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CARBURETTOR AND INJECTOR FUELLING
MIXTURE LOOP AT 40 REV/SEC 2.5 BAR BMEP
CARBURETTOR
INJECTED
NOx (g/kW.h)
CO (g/kW.h)
HC (g/kW.h)
BRAKE THERMAL EFF. (%)
LEAN
EQUIVALENCE RATIO
RICH
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
150
100
50
0
24
22
20
18
15
10
5
0
30
20
10
0



RICARDO
Fig.No. 64
Drg.No.
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
Date: 30 Apr 1986
COMPARISON BETWEEN CARBURETTOR AND INJECTOR FUELLING
MIXTURE LOOP AT 40 REV/SEC 2.5 BAR BMEP
CARBURETTOR
INJECTED
EXHAUST TEMPERATURE (C)
550
500
450
400
350
IN.MAN.PRESS. (m.bar)
700
600
500
400
IGNITION TIMING (BTDC)
50
40
30
20
10
LEAN
EQUIVALENCE RATIO
RICH
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2


RICARDO
Fig.No. 65
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CARBURETTOR AND INJECTOR FUELLING
MIXTURE LOOP AT 40 REV/SEC 2.5 BAR BMEP
CARBURETTOR
INJECTED
NOx (PPM)
CO (%)
HC (PPMc)
3000
2000
1000
0
3
2
1
0
6000
4000
2000
0
LEAN
EQUIVALENCE RATIO
RICH
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2


RICARDO
Fig.No.66
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CARBURETTOR AND INJECTOR FUELLING
MIXTURE LOOP AT 40 REV/SEC 2.5 BAR BMEP
CARBURETTOR
INJECTED
HC+NOx (g/kW.h)
BRAKE THERMAL EFFICIENCY (%)
30
25
20
15
10
5
28
26
24
22
20
18
LEAN
EQUIVALENCE RATIO
RICH
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2


RICARDO
Fig.No.67
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CARBURETTOR AND INJECTOR FUELLING
MIXTURE LOOP AT 40 REV/SEC 5.5 BAR BMEP
CARBURETTOR
INJECTED
NOx (g/kW.h)
CO (g/kW.h)
HC (g/kW.h)
BRAKE THERMAL EFF. (%)
LEAN
EQUIVALENCE RATIO
RICH
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
0
10
20
30
0
5
10
15
0
50
100
150
26
28
30
32

RICARDO

Fig.No.68

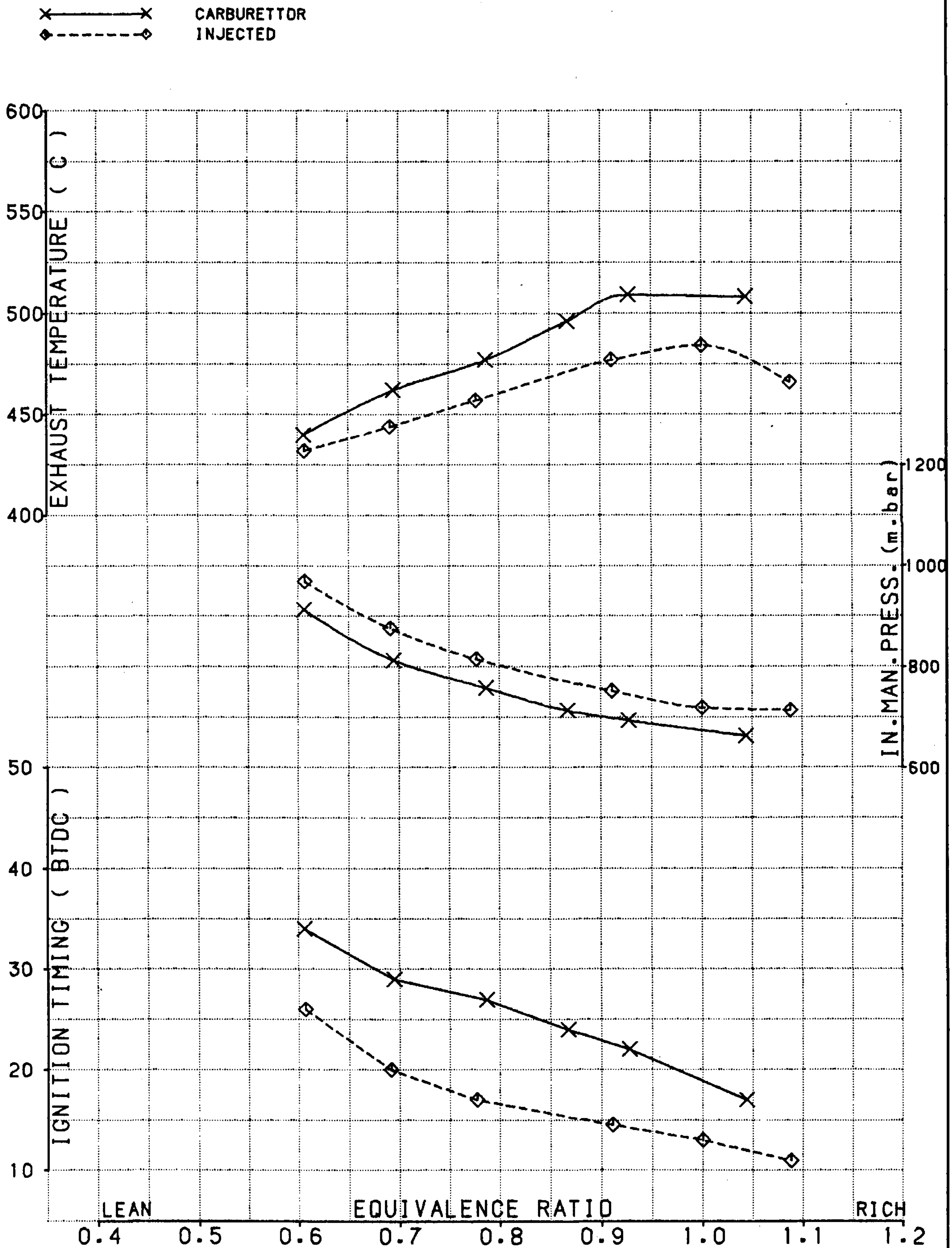
Drg.No.

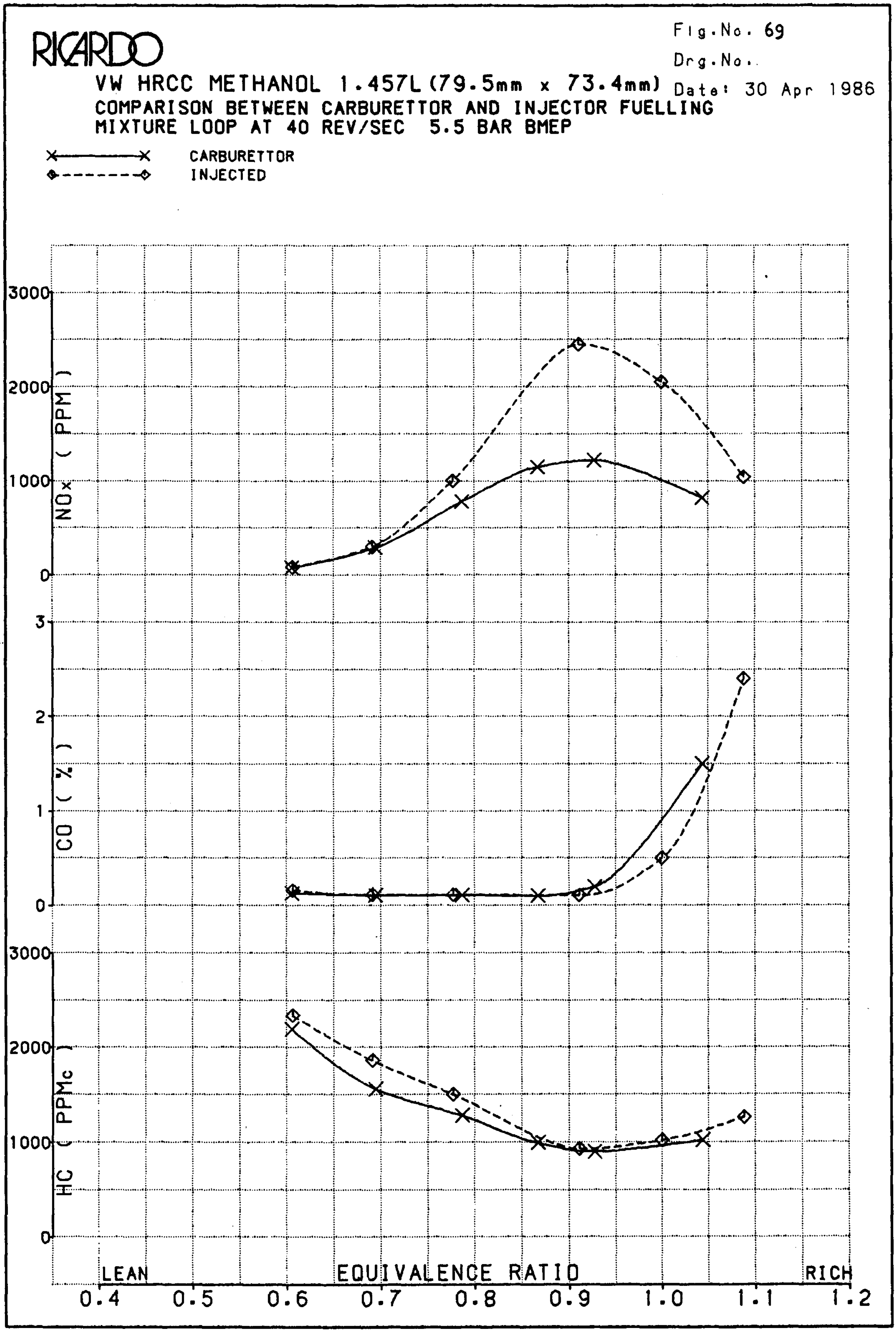
Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

COMPARISON BETWEEN CARBURETTOR AND INJECTOR FUELLING

MIXTURE LOOP AT 40 REV/SEC 5.5 BAR BMEP




RICARDO
Fig.No. 69
Drg.No.
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
Date: 30 Apr 1986
COMPARISON BETWEEN CARBURETTOR AND INJECTOR FUELLING
MIXTURE LOOP AT 40 REV/SEC 5.5 BAR BMEP
CARBURETTOR
INJECTED
NOx (PPM)
3000
2000
1000
0
CO (%)
3
2
1
0
HC (PPMc)
3000
2000
1000
0
LEAN
EQUIVALENCE RATIO
RICH
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2

RICARDO

Fig.No. 70
Drg.No.
Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CARBURETTOR AND INJECTOR FUELLING
MIXTURE LOOP AT 40 REV/SEC 5.5 BAR BMEP

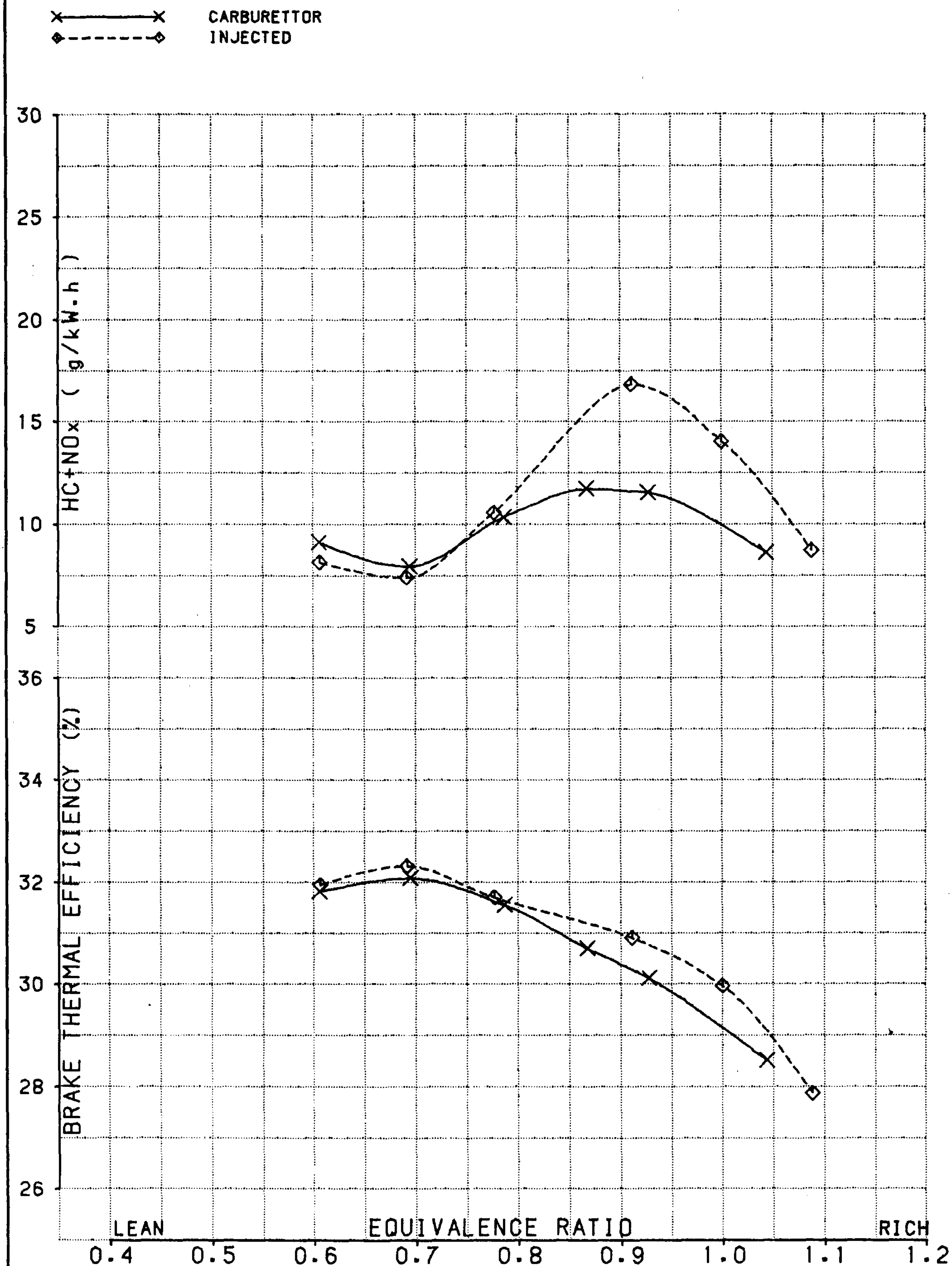
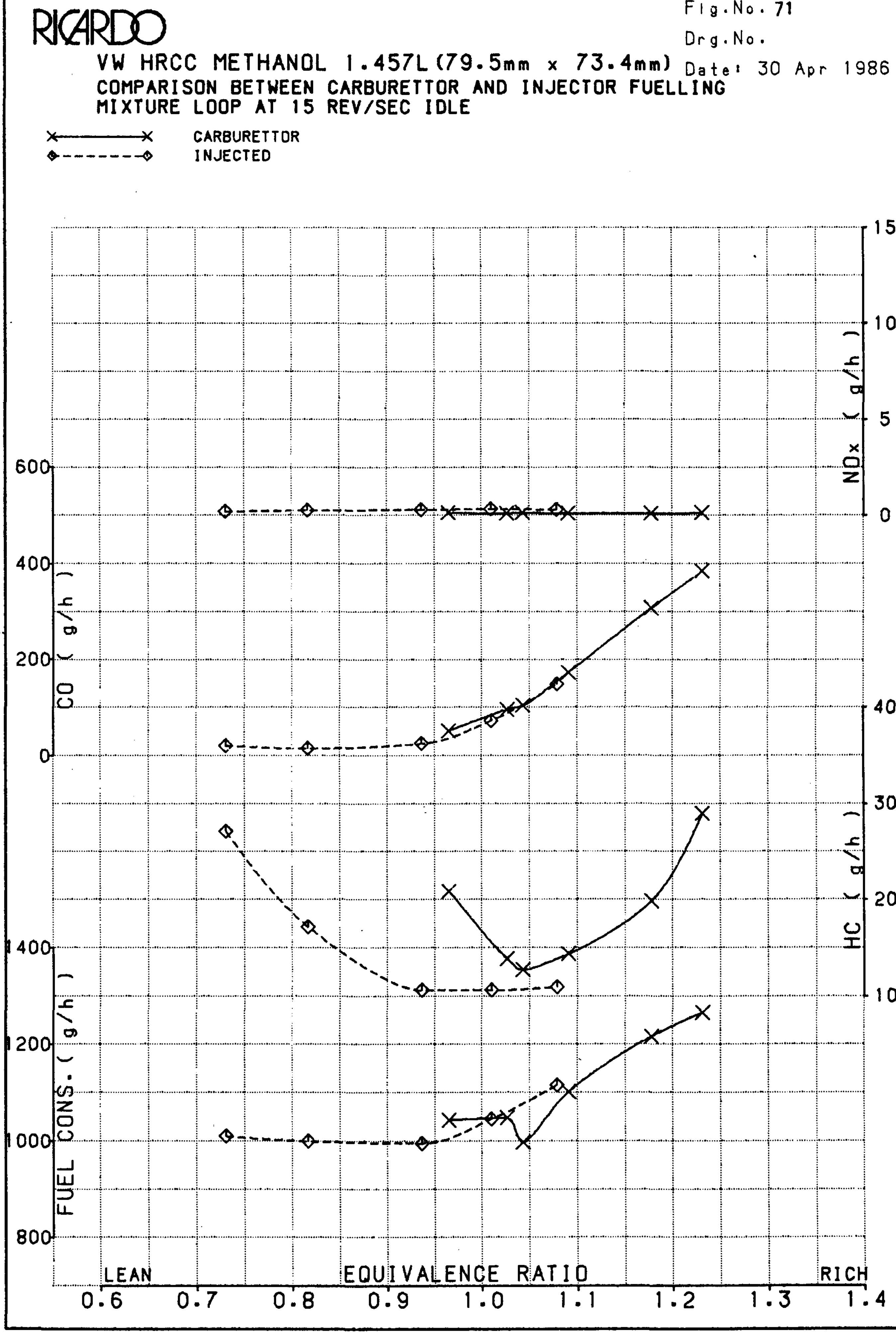


Fig.No. 71

Drg.No.

Date: 30 Apr 1986



RICARDO

Fig.No. 72

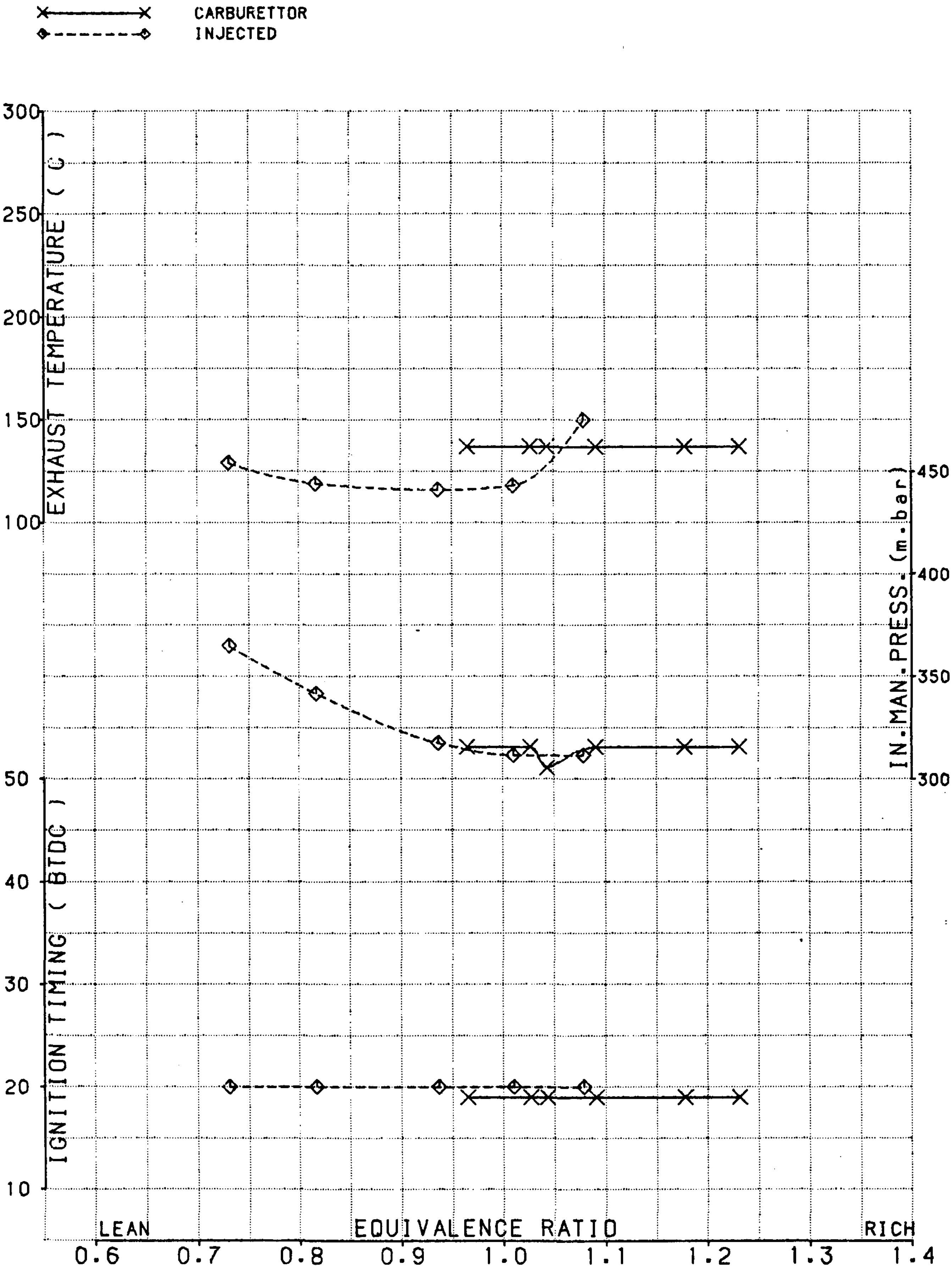
Drg.No.

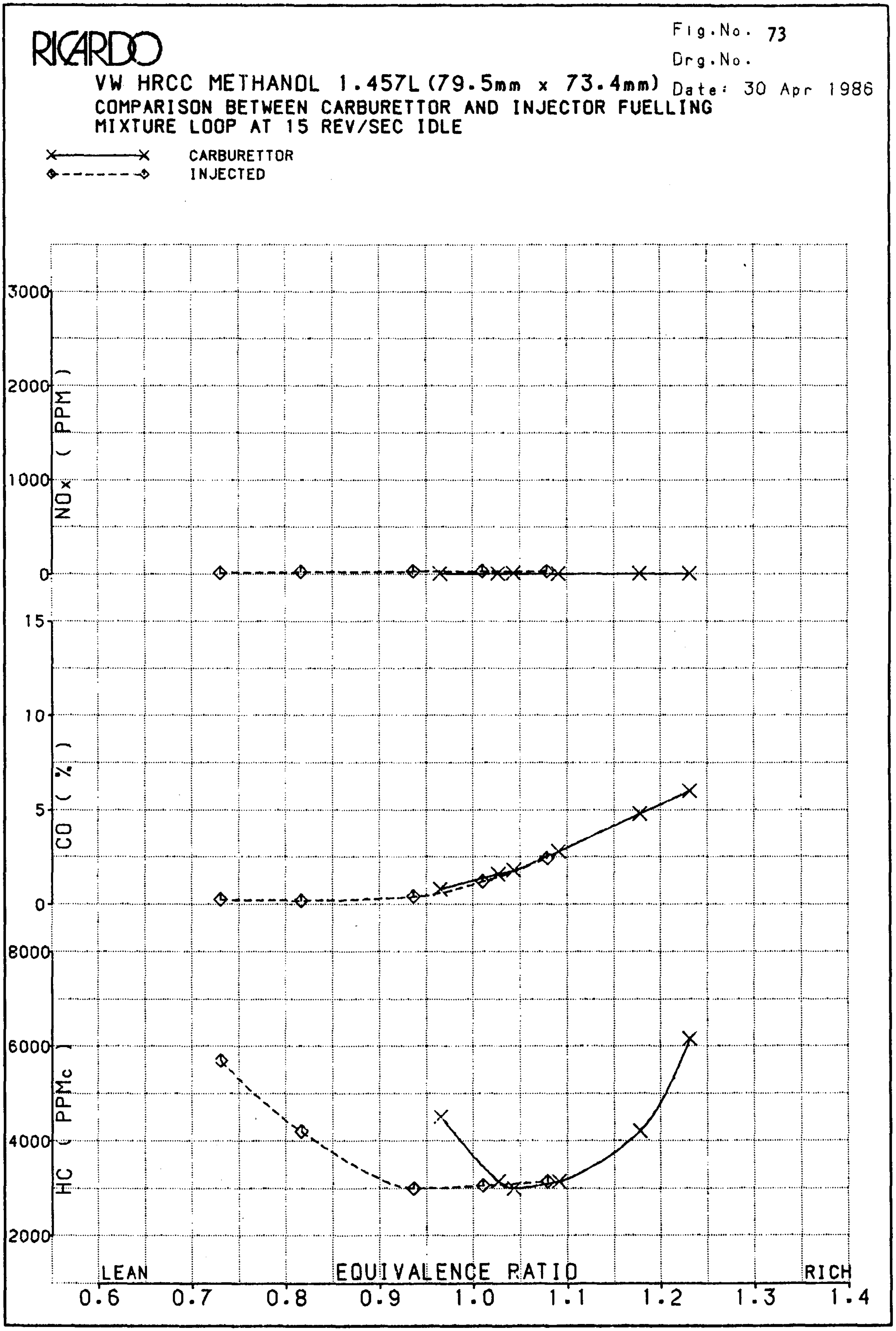
Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

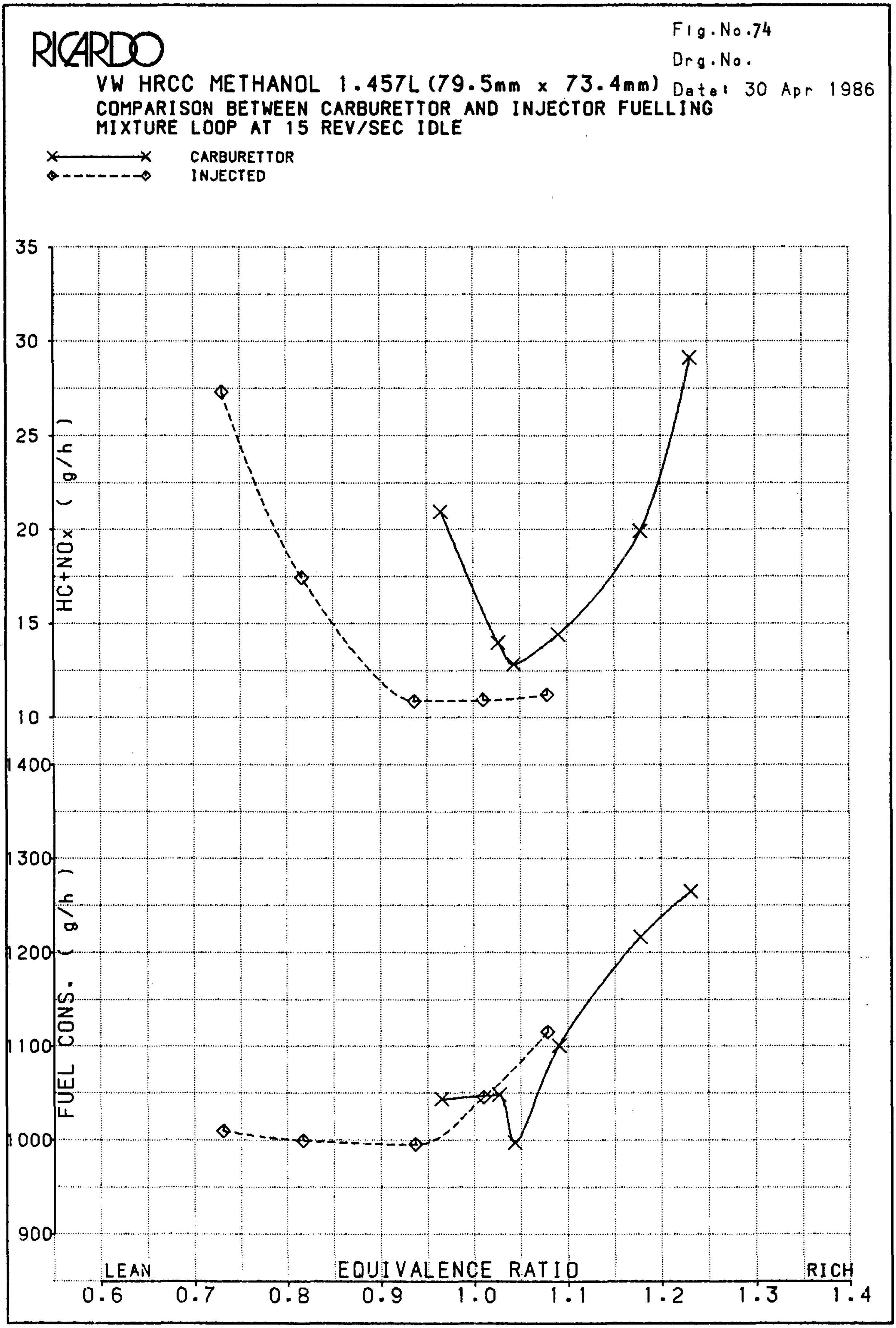
COMPARISON BETWEEN CARBURETTOR AND INJECTOR FUELLING

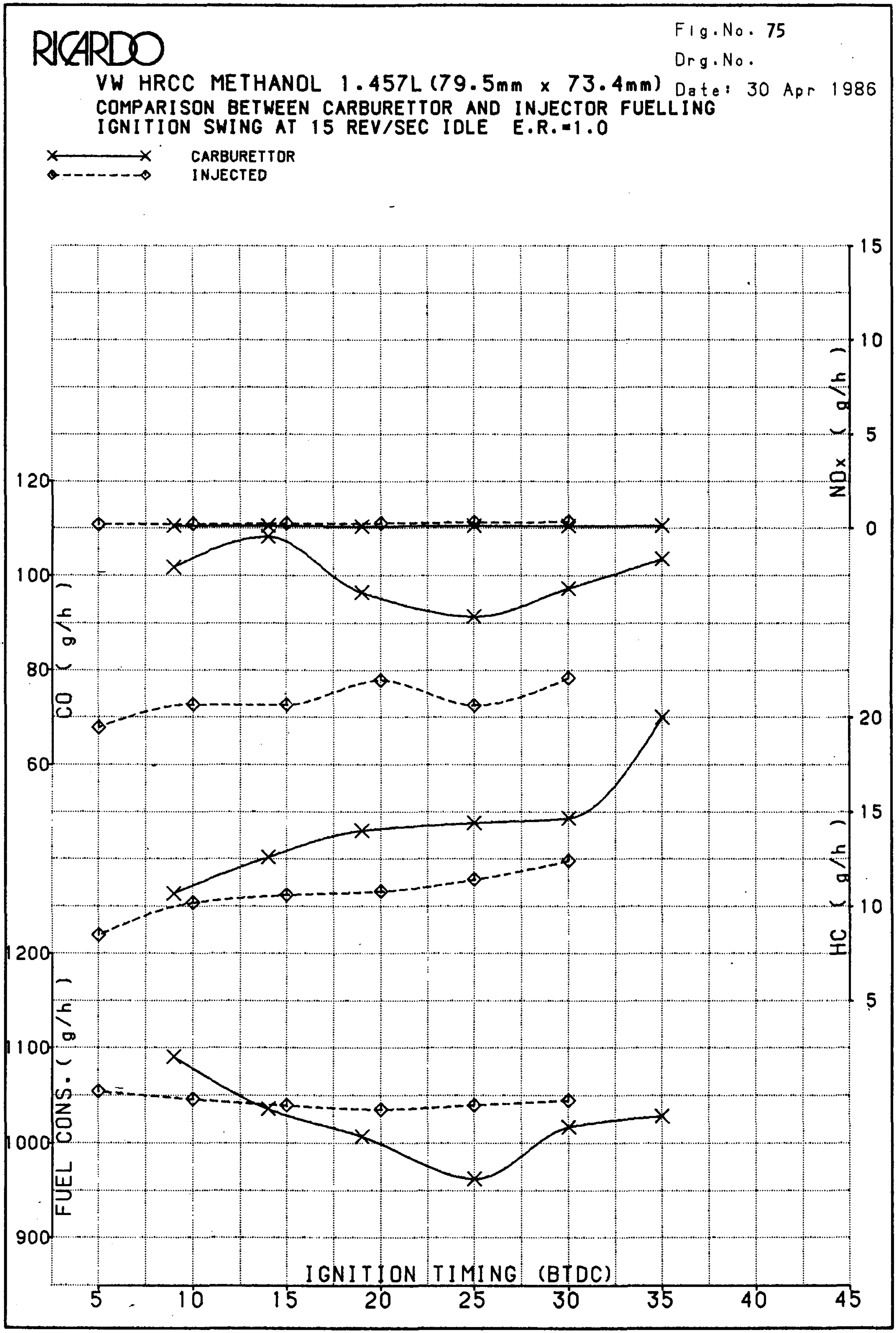
MIXTURE LOOP AT 15 REV/SEC IDLE





RICARDO
Fig.No. 73
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CARBURETTOR AND INJECTOR FUELLING
MIXTURE LOOP AT 15 REV/SEC IDLE
CARBURETTOR
INJECTED
NOx (PPM)
3000
2000
1000
0
CO (%)
15
10
5
0
HC (PPMc)
8000
6000
4000
2000
LEAN
EQUIVALENCE RATIO
RICH
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4


RICARDO
Fig.No.74
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CARBURETTOR AND INJECTOR FUELLING
MIXTURE LOOP AT 15 REV/SEC IDLE
CARBURETTOR
INJECTED
HC+NOx (g/h)
35
30
25
20
15
10
FUEL CONS. (g/h)
1400
1300
1200
1100
1000
900
LEAN
EQUIVALENCE RATIO
RICH
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4


RICARDO
Fig.No. 75
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CARBURETTOR AND INJECTOR FUELLING
IGNITION SWING AT 15 REV/SEC IDLE E.R.=1.0
CARBURETTOR
INJECTED
NOx (g/h)
15
10
5
0
CO (g/h)
120
100
80
60
HC (g/h)
20
15
10
5
FUEL CONS. (g/h)
1200
1100
1000
900
IGNITION TIMING (BTDC)
5
10
15
20
25
30
35
40
45

RICARDO

Fig.No. 76

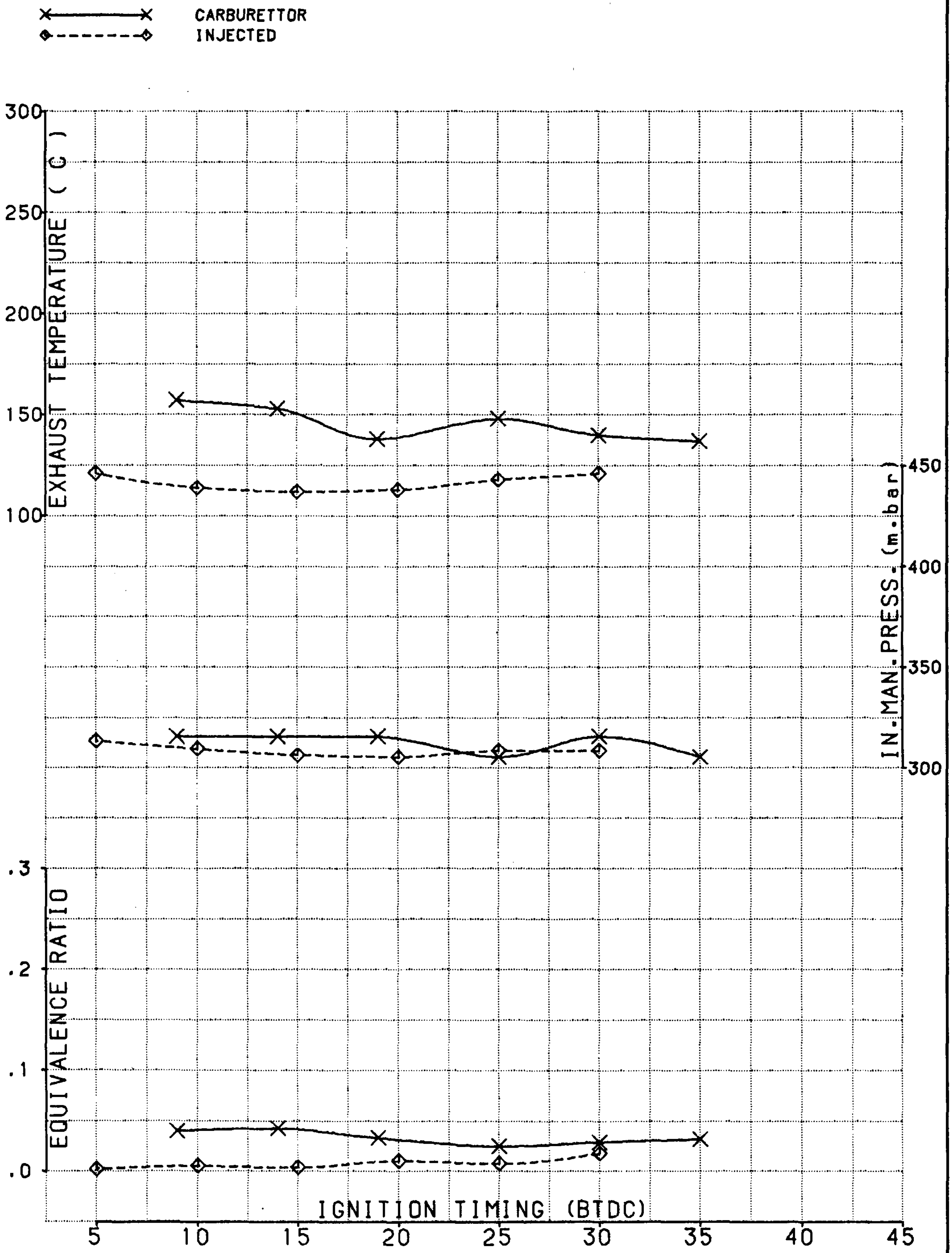
Drg.No.

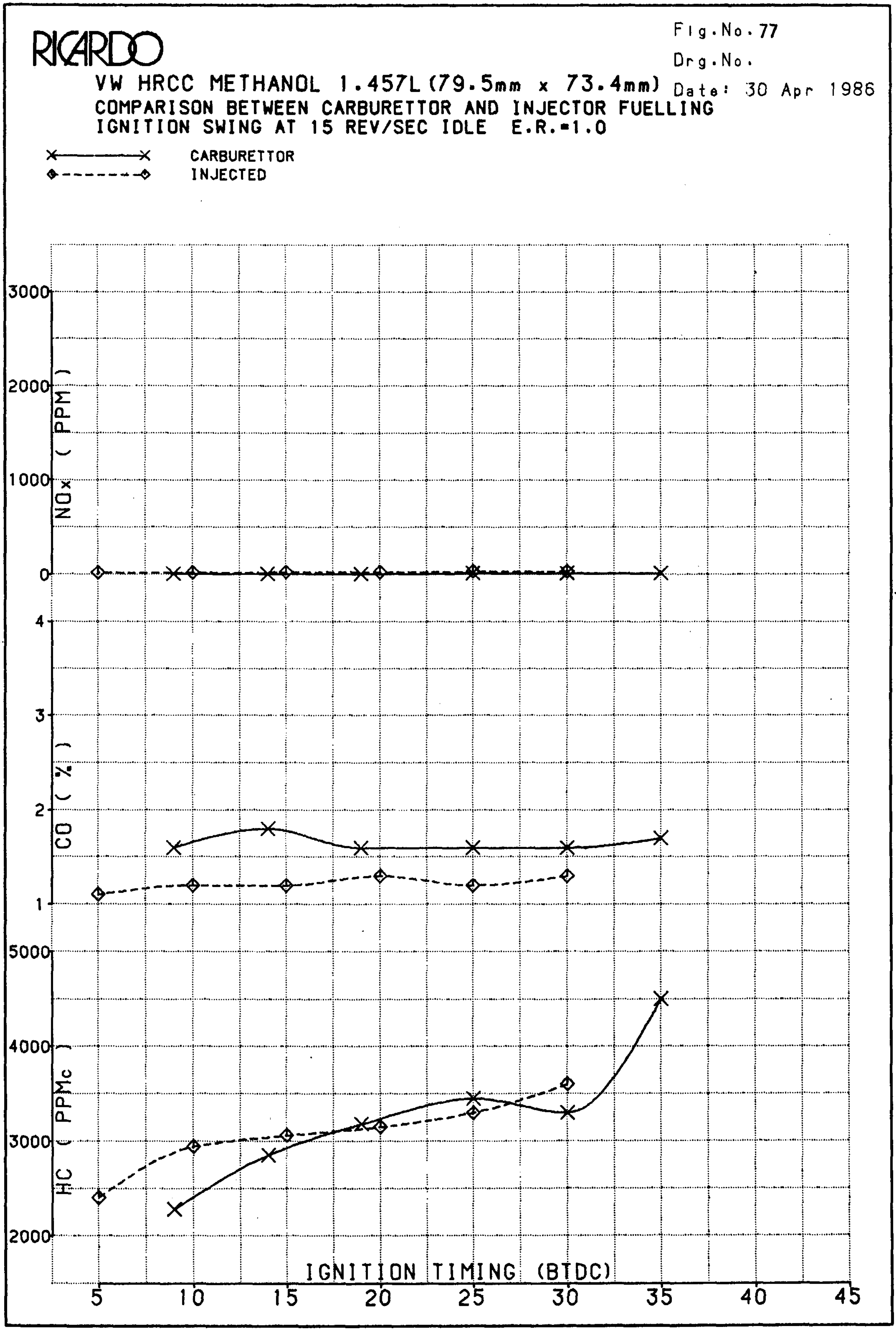
Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

COMPARISON BETWEEN CARBURETTOR AND INJECTOR FUELLING

IGNITION SWING AT 15 REV/SEC IDLE E.R.=1.0



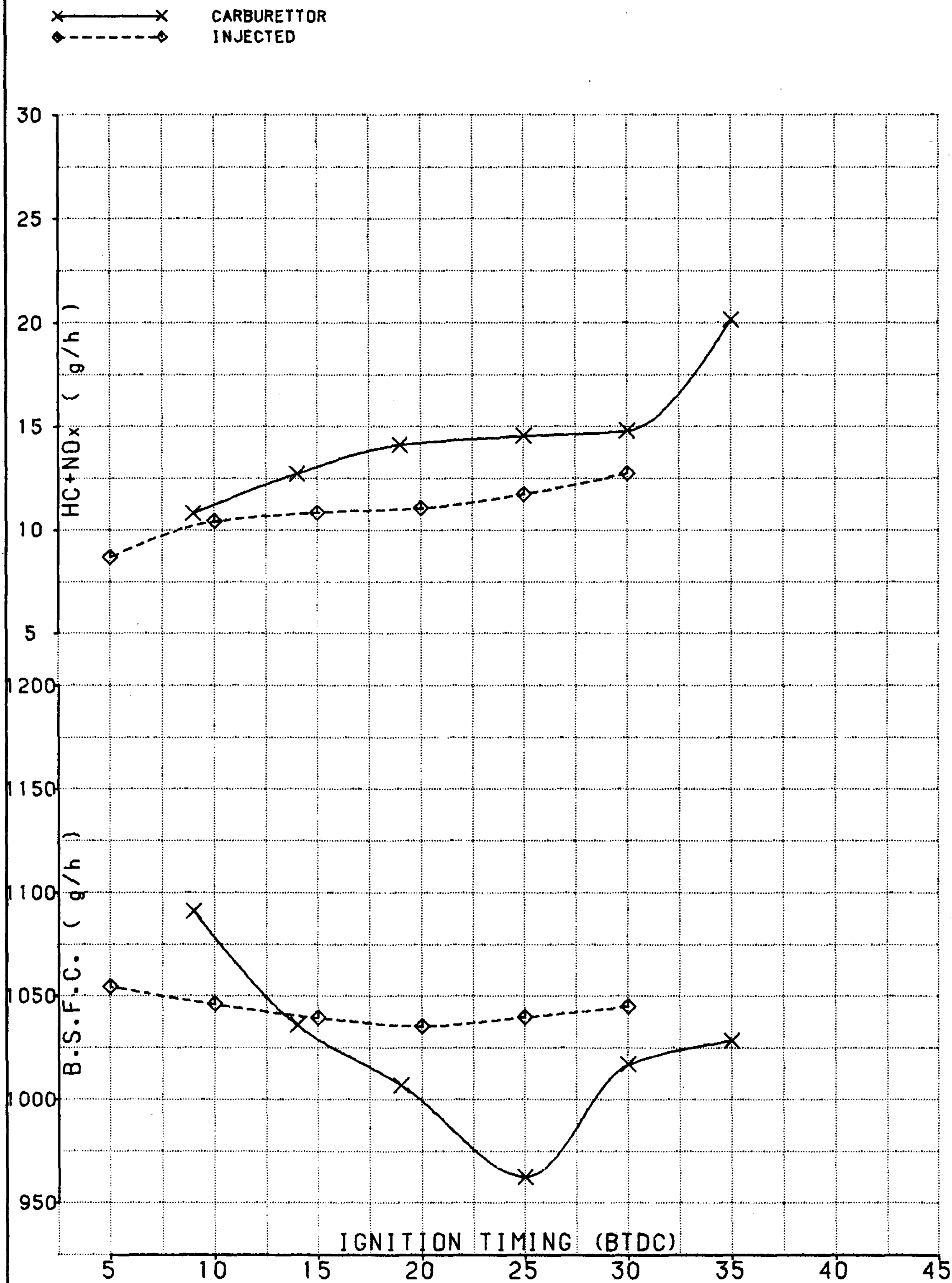


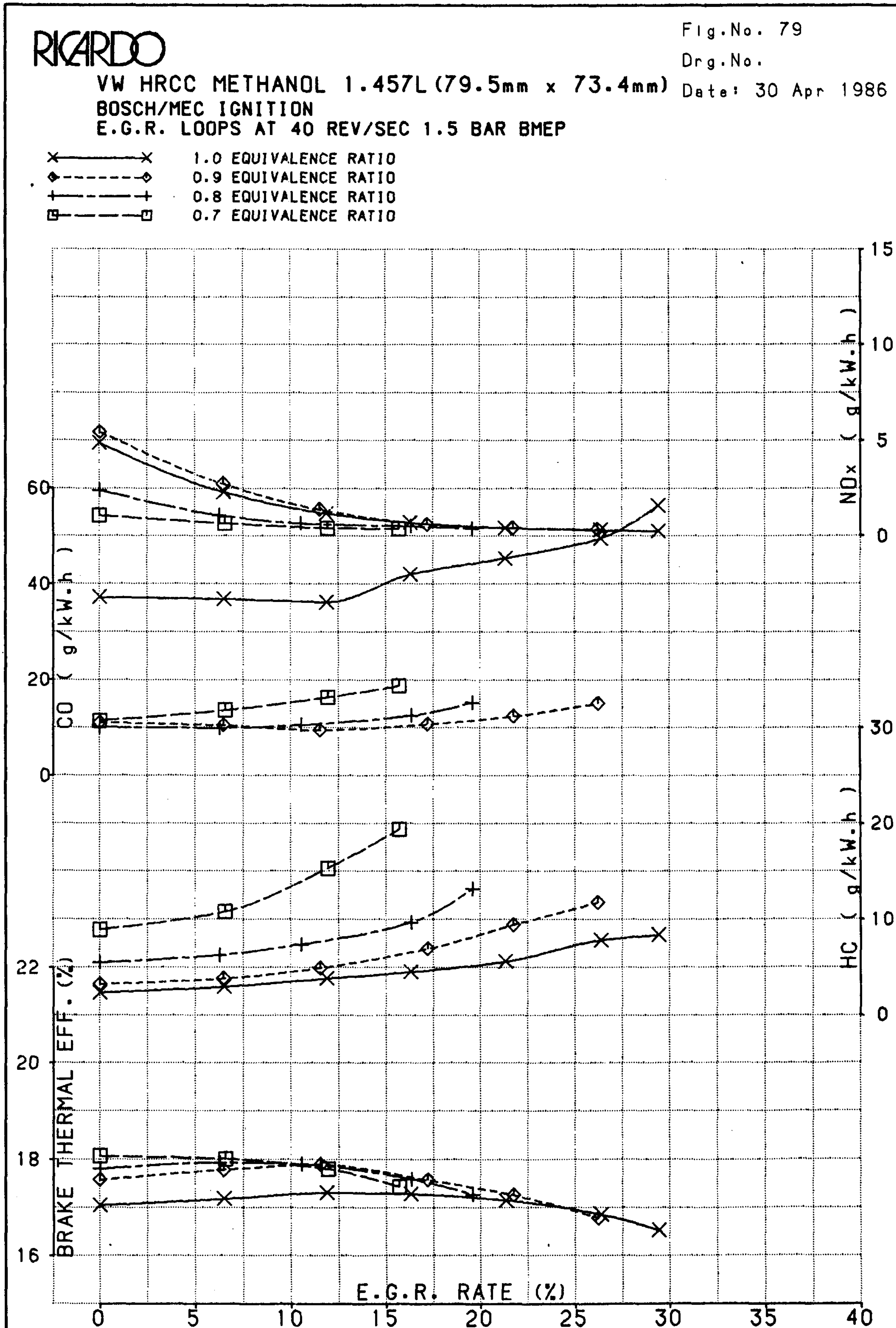
RICARDO
Fig.No.77
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CARBURETTOR AND INJECTOR FUELLING
IGNITION SWING AT 15 REV/SEC IDLE E.R.=1.0
CARBURETTOR
INJECTED
NOx (PPM)
CO (%)
HC (PPMc)
IGNITION TIMING (BTDC)

Fig.No. 78
Drg.No.
Date: 30 Apr 1986

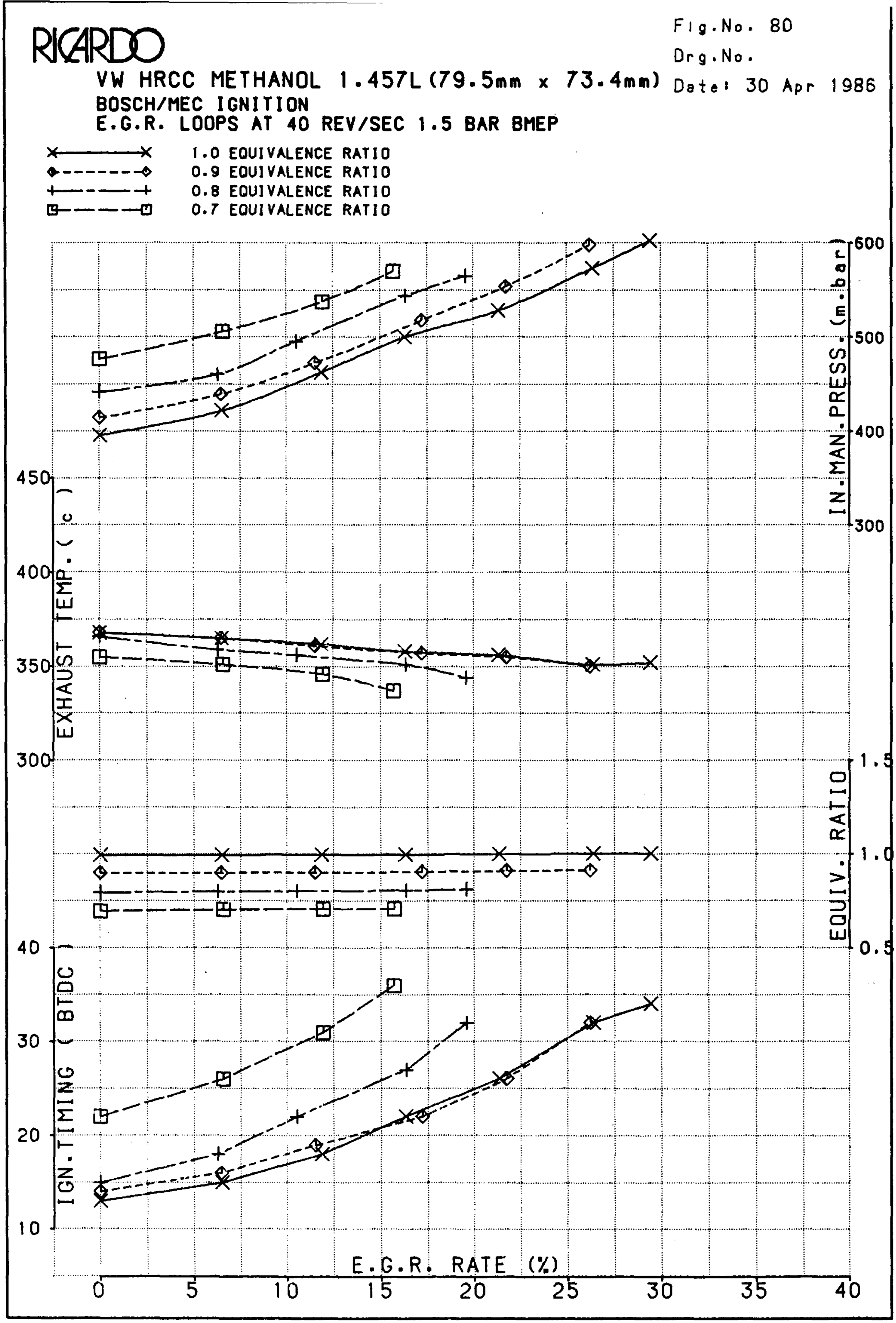
RICARDO

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
COMPARISON BETWEEN CARBURETTOR AND INJECTOR FUELLING
IGNITION SWING AT 15 REV/SEC IDLE E.R.=1.0





RICARDO
Fig.No. 79
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 40 REV/SEC 1.5 BAR BMEP
1.0 EQUIVALENCE RATIO
0.9 EQUIVALENCE RATIO
0.8 EQUIVALENCE RATIO
0.7 EQUIVALENCE RATIO
NOx (g/kW.h)
CO (g/kW.h)
HC (g/kW.h)
BRAKE THERMAL EFF. (%)
E.G.R. RATE (%)
0
5
10
15
20
25
30
35
40
60
40
20
0
22
20
18
16
15
10
5
0
30
20
10
0

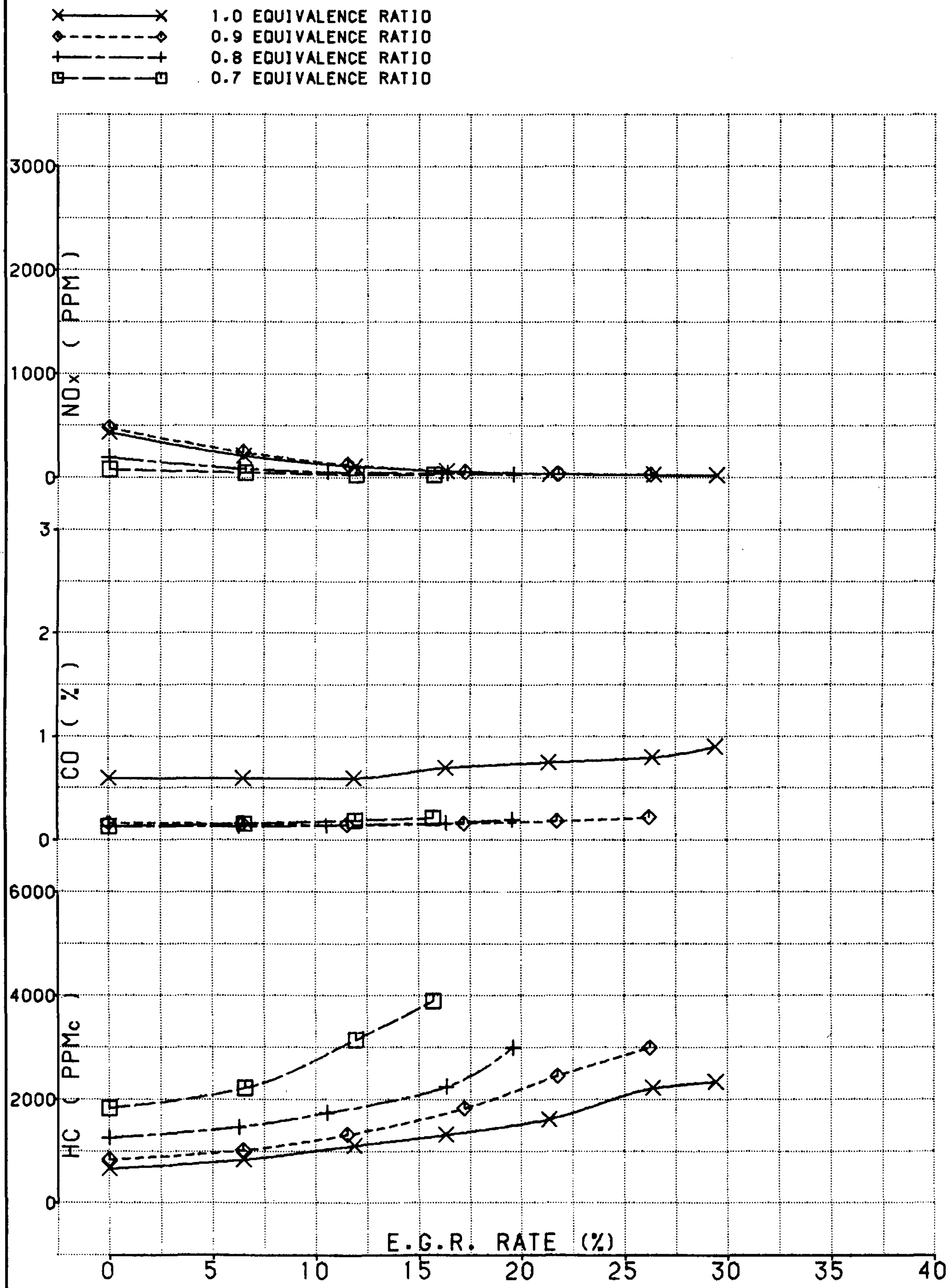


RICARDO
Fig.No. 80
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 40 REV/SEC 1.5 BAR BMEP
1.0 EQUIVALENCE RATIO
0.9 EQUIVALENCE RATIO
0.8 EQUIVALENCE RATIO
0.7 EQUIVALENCE RATIO
IN.MAN.PRESS.(m.bar)
600
500
400
300
EXHAUST TEMP.(c)
450
400
350
300
EQUIV. RATIO
1.5
1.0
0.5
IGN.TIMING (BTDC)
40
30
20
10
E.G.R. RATE (%)
0
5
10
15
20
25
30
35
40

RICARDO

Fig.No. 81
Drg.No.
Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 40 REV/SEC 1.5 BAR BMEP



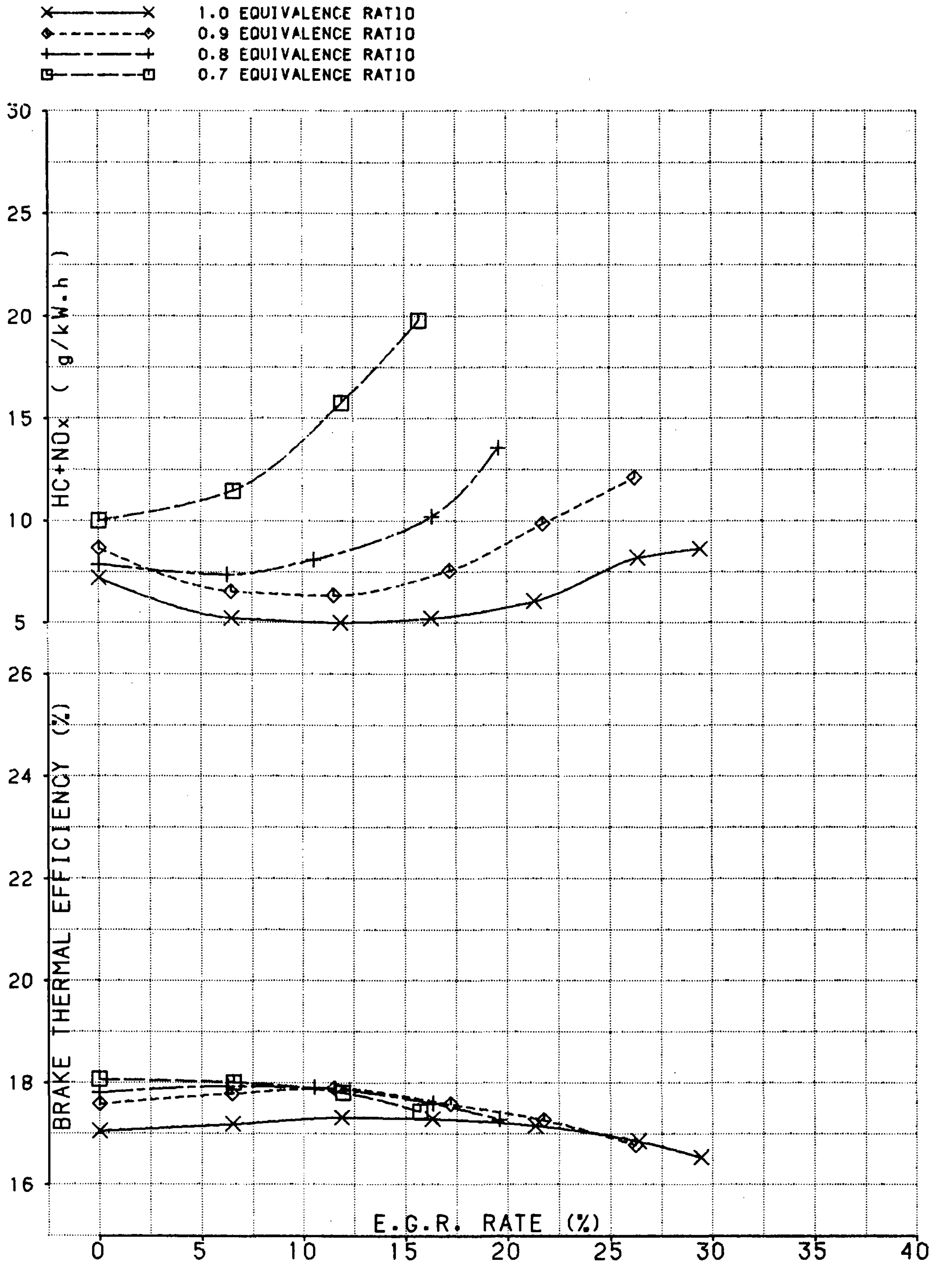
RICARDO

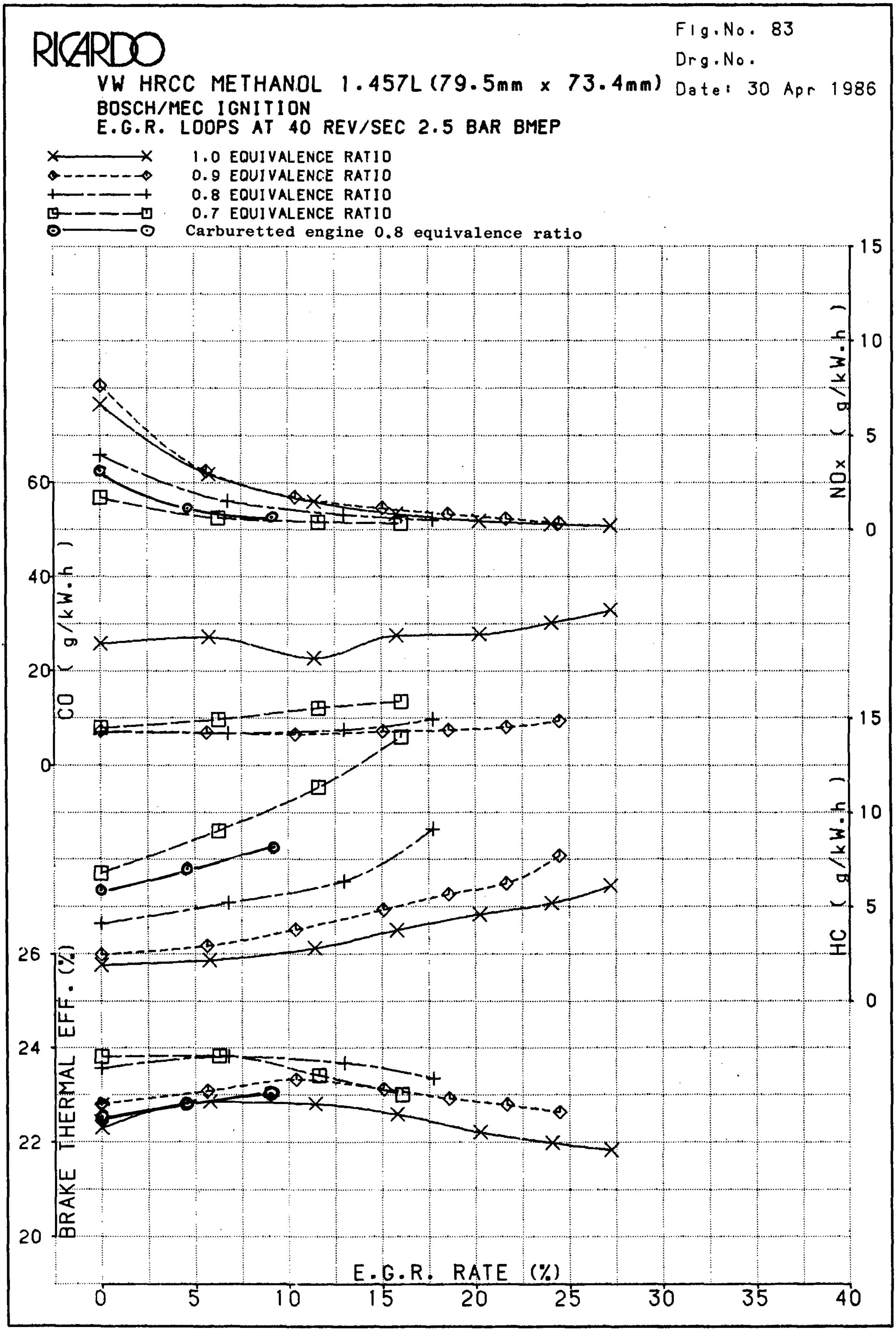
Fig.No. 82

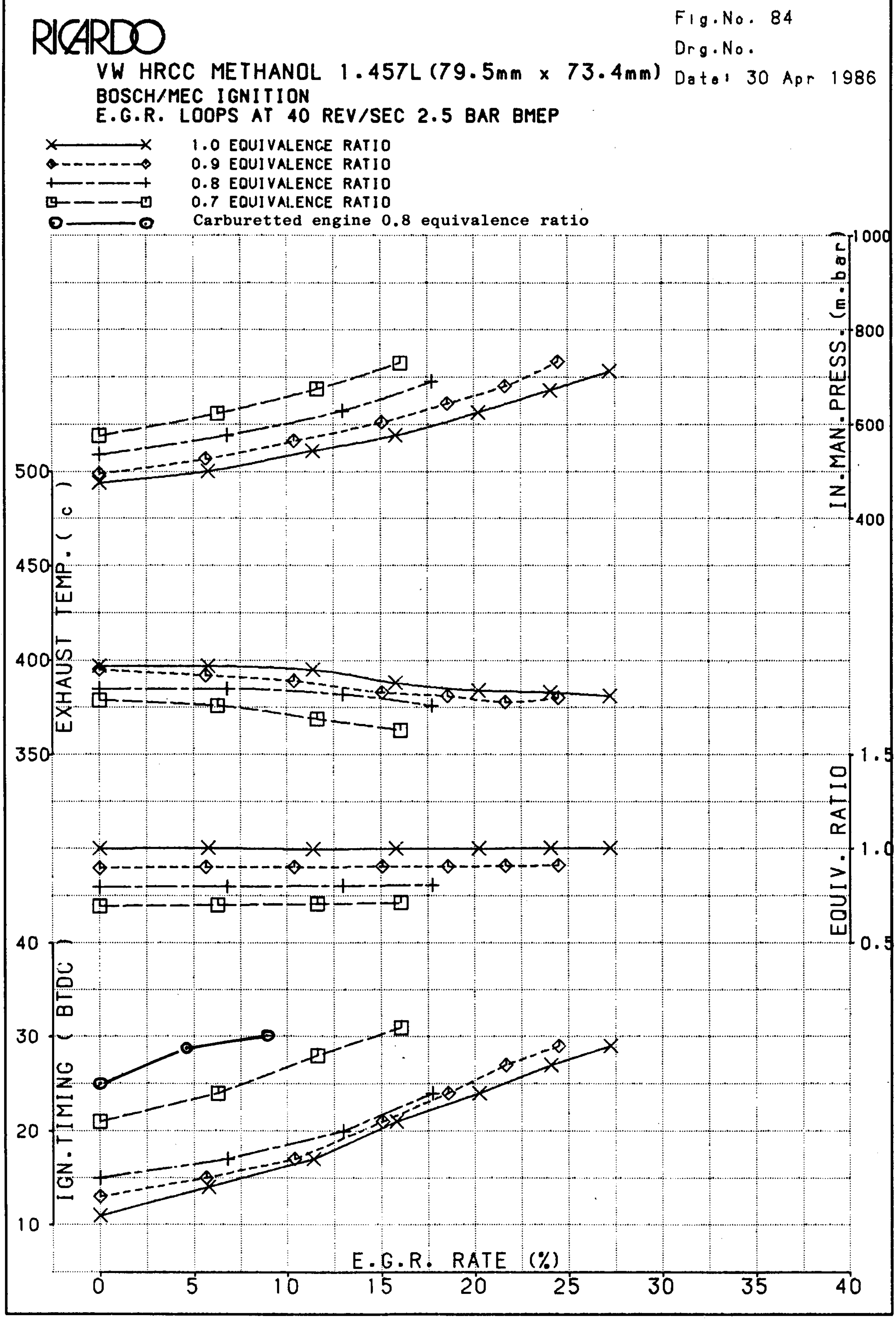
Drg.No.

Date: 30 Apr 1986

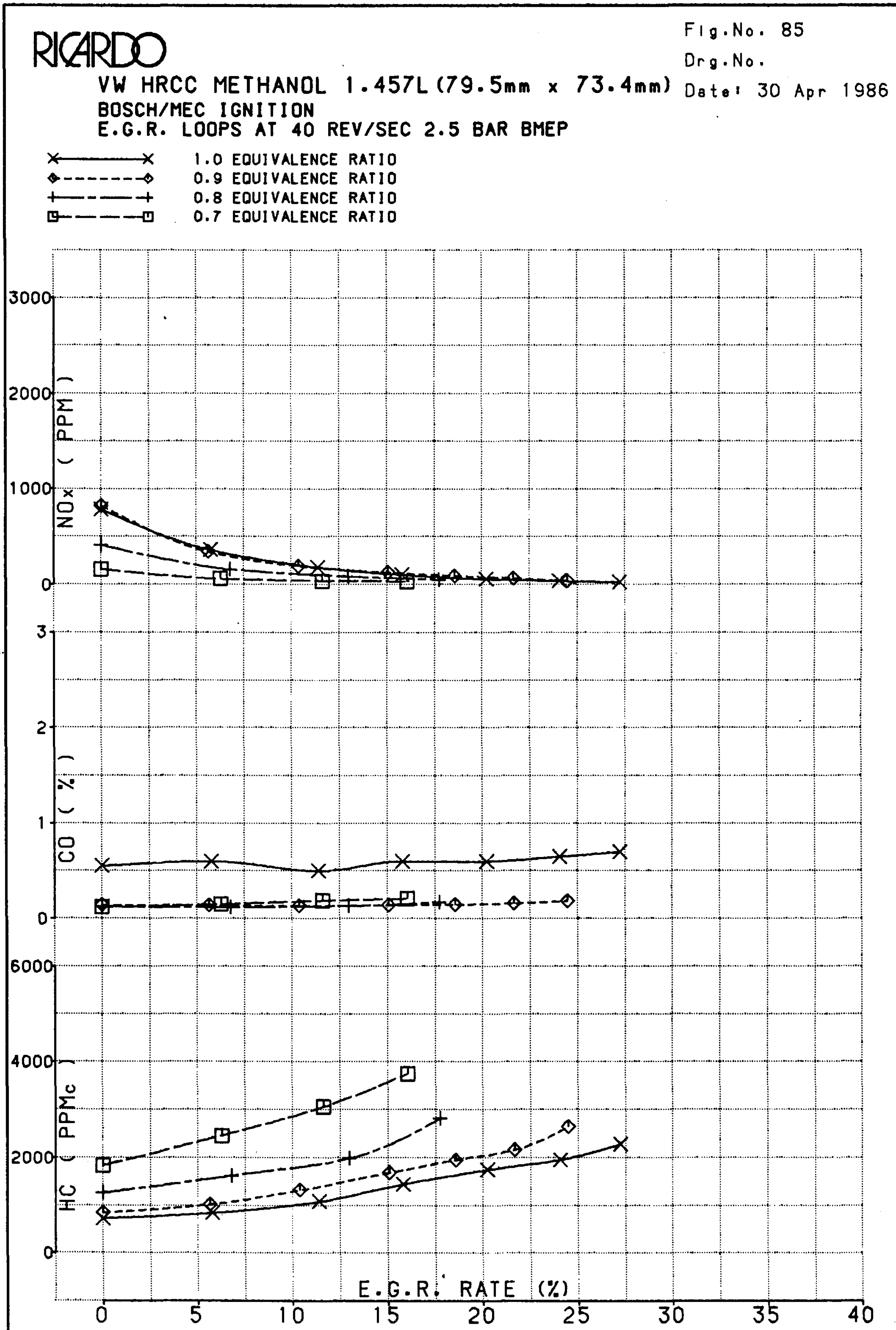
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 40 REV/SEC 1.5 BAR BMEP



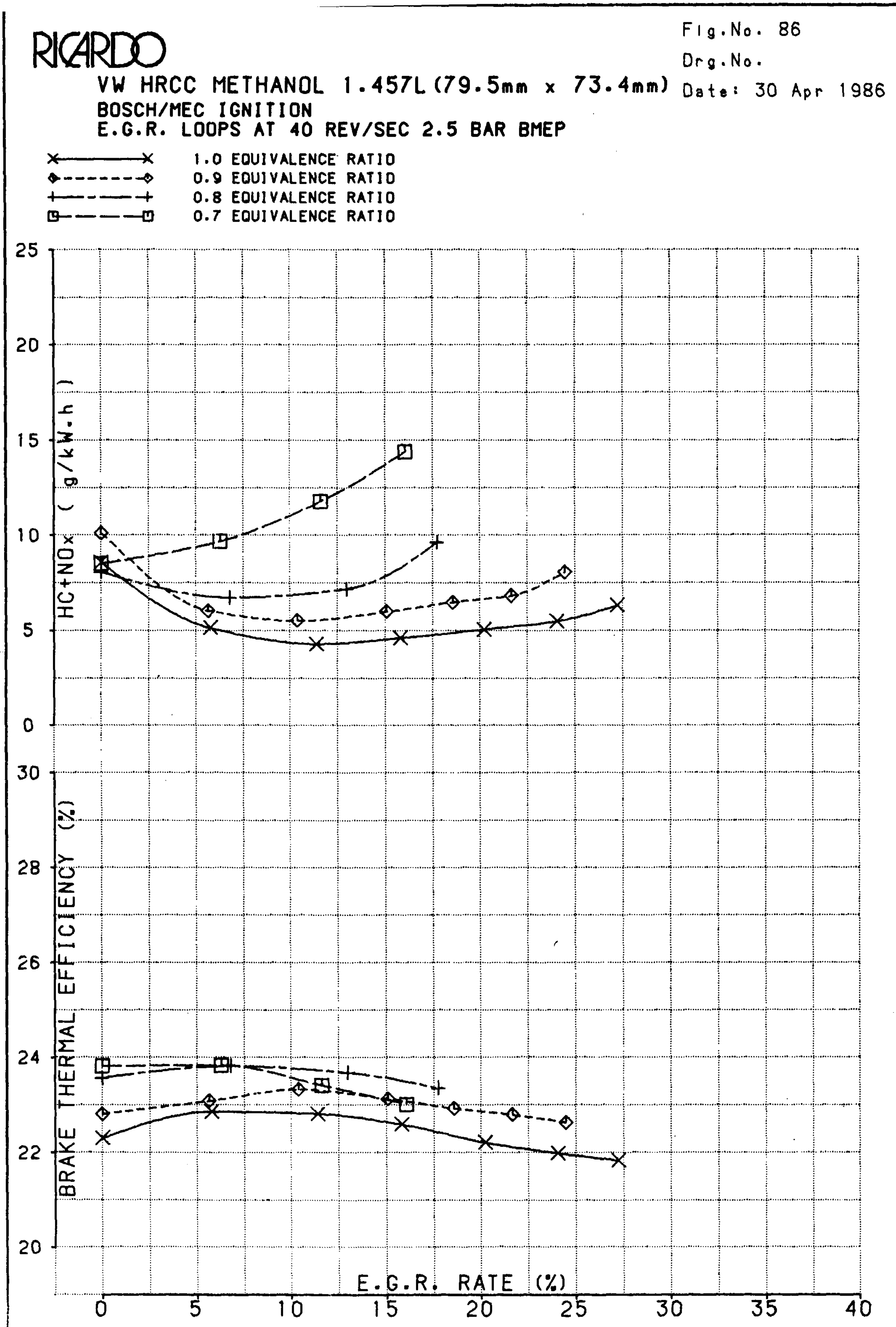

RICARDO
Fig.No. 83
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 40 REV/SEC 2.5 BAR BMEP
1.0 EQUIVALENCE RATIO
0.9 EQUIVALENCE RATIO
0.8 EQUIVALENCE RATIO
0.7 EQUIVALENCE RATIO
Carburetted engine 0.8 equivalence ratio
NOx (g/kW.h)
CO (g/kW.h)
HC (g/kW.h)
BRAKE THERMAL EFF. (%)
E.G.R. RATE (%)
0
5
10
15
20
25
30
35
40
60
40
20
0
26
24
22
20
15
10
5
0
15
10
5
0



RICARDO
Fig.No. 84
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 40 REV/SEC 2.5 BAR BMEP
1.0 EQUIVALENCE RATIO
0.9 EQUIVALENCE RATIO
0.8 EQUIVALENCE RATIO
0.7 EQUIVALENCE RATIO
Carburetted engine 0.8 equivalence ratio
IN.MAN.PRESS. (m.bar)
1000
800
600
400
EXHAUST TEMP. (c)
500
450
400
350
EQUIV. RATIO
1.5
1.0
0.5
IGN. TIMING (BTDC)
40
30
20
10
E.G.R. RATE (%)
0
5
10
15
20
25
30
35
40



RICARDO
Fig.No. 85
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 40 REV/SEC 2.5 BAR BMEP
1.0 EQUIVALENCE RATIO
0.9 EQUIVALENCE RATIO
0.8 EQUIVALENCE RATIO
0.7 EQUIVALENCE RATIO
NOx (PPM)
3000
2000
1000
0
CO (%)
3
2
1
0
HC (PPMc)
6000
4000
2000
0
E.G.R. RATE (%)
0
5
10
15
20
25
30
35
40

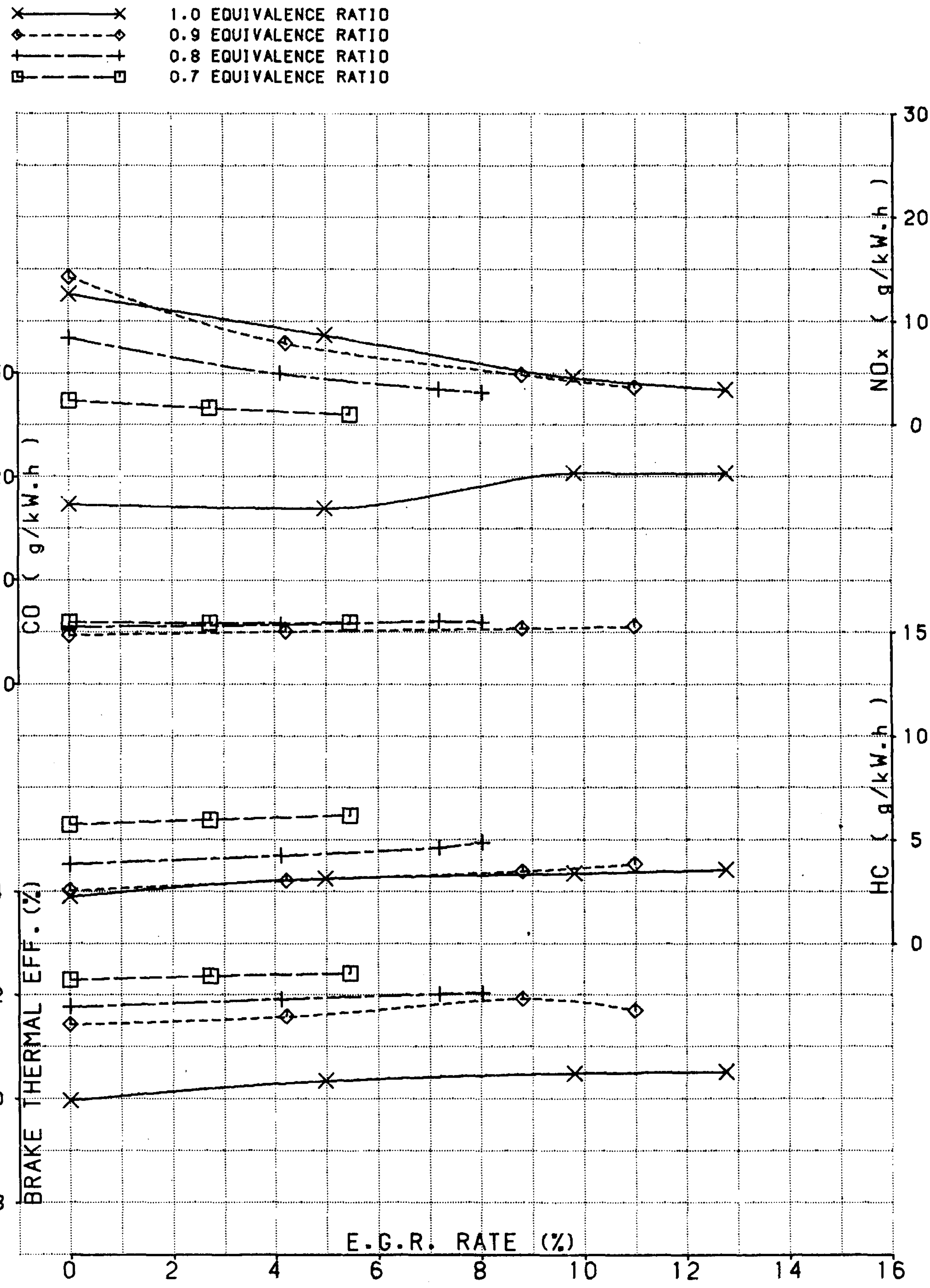


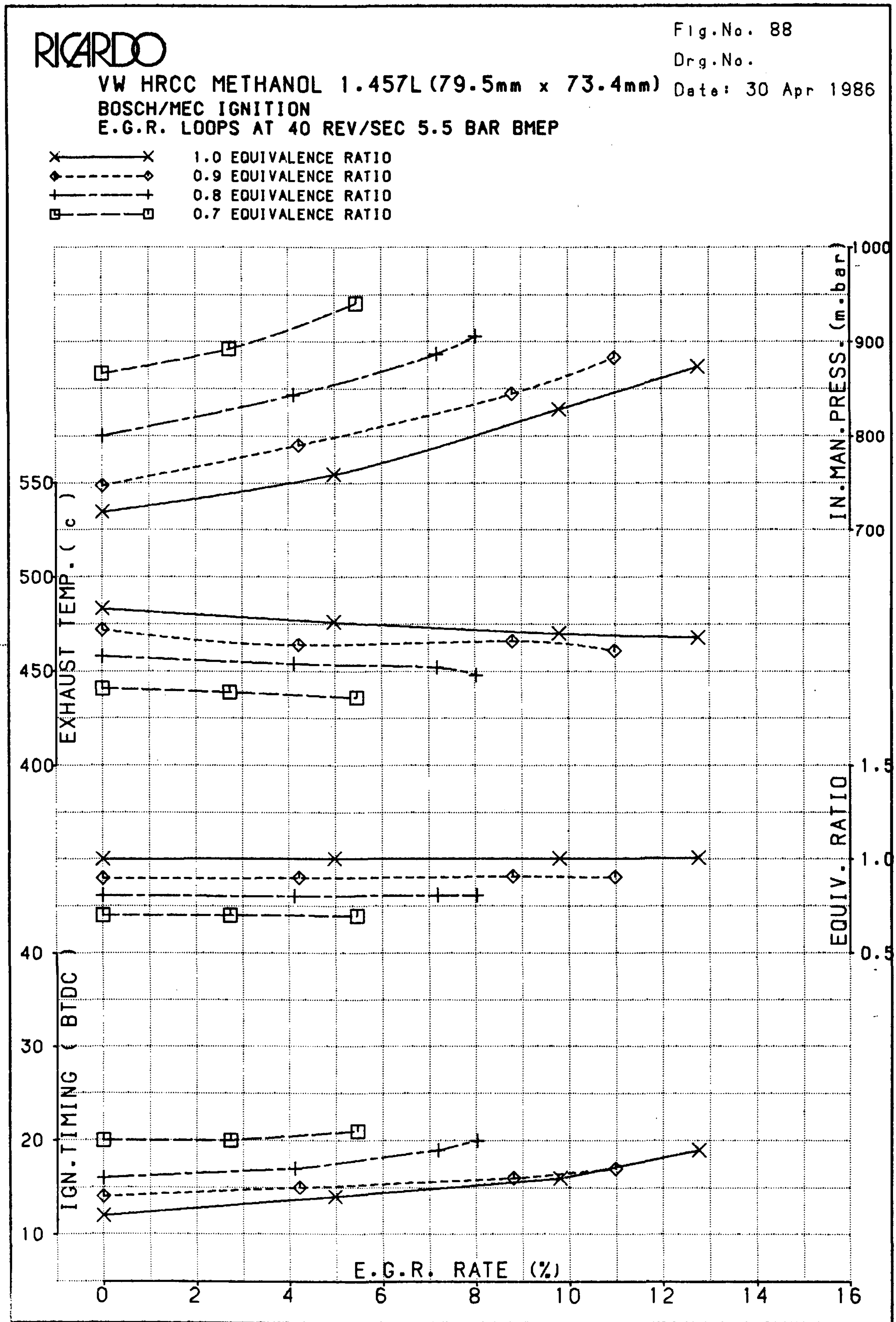
RICARDO
Fig.No. 86
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 40 REV/SEC 2.5 BAR BMEP
1.0 EQUIVALENCE RATIO
0.9 EQUIVALENCE RATIO
0.8 EQUIVALENCE RATIO
0.7 EQUIVALENCE RATIO
HC+NOx (g/kW.h)
BRAKE THERMAL EFFICIENCY (%)
E.G.R. RATE (%)
0
5
10
15
20
25
30
35
40
22
24
26
28

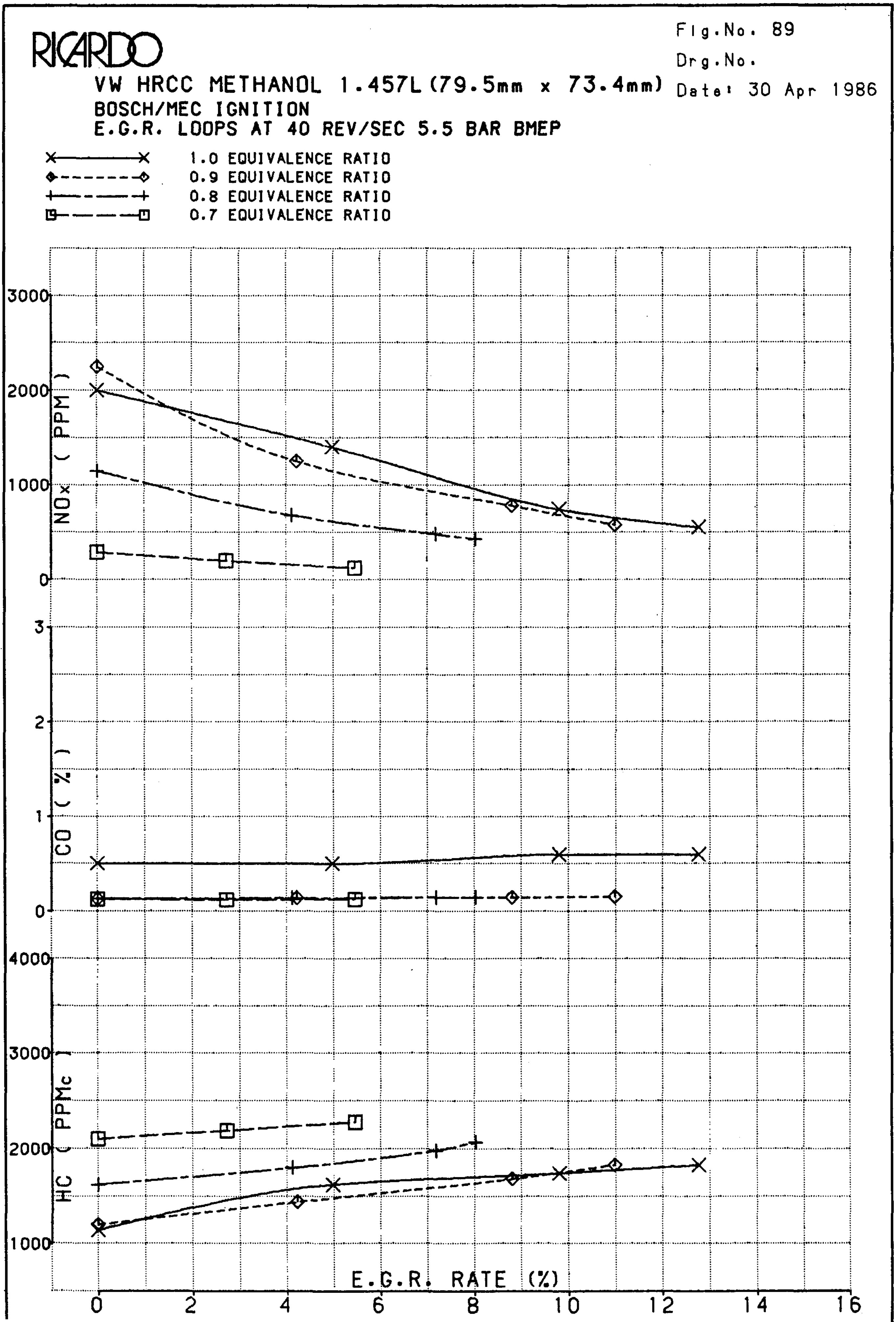
RICARDO

Fig.No. 87
Drg.No.
Date: 30 Apr 1986

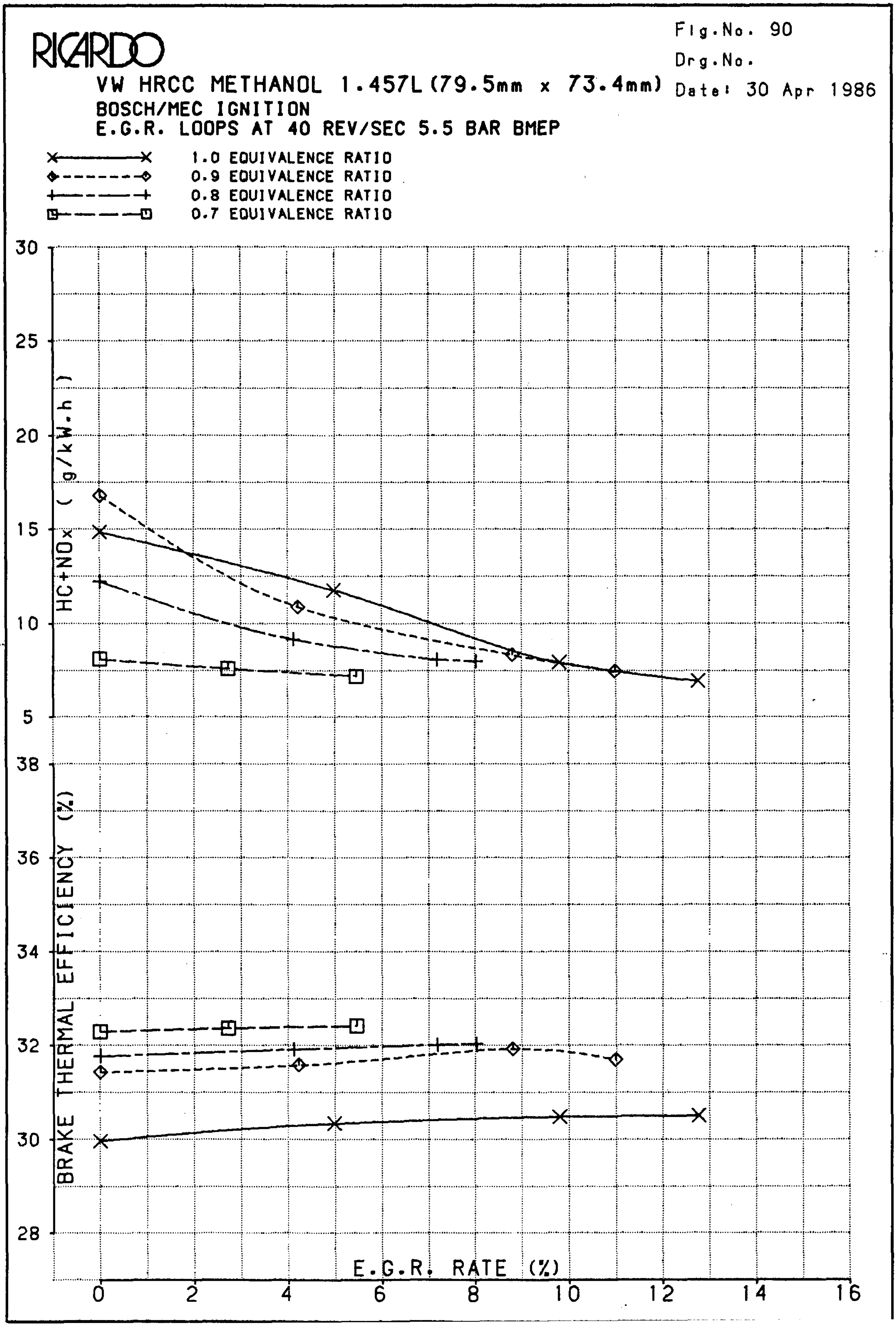
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 40 REV/SEC 5.5 BAR BMEP

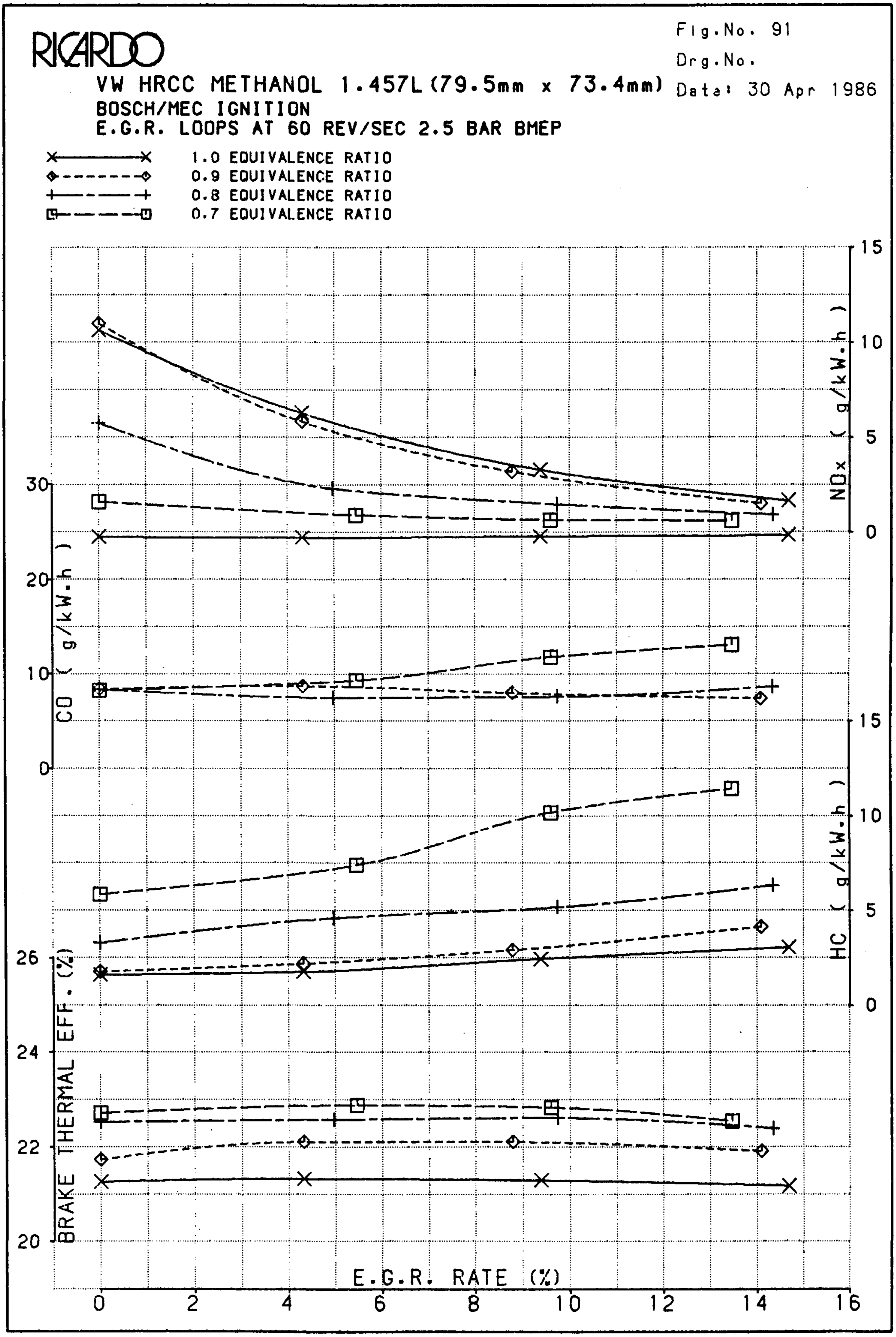



RICARDO
Fig.No. 88
Drg.No.
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
Date: 30 Apr 1986
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 40 REV/SEC 5.5 BAR BMEP
1.0 EQUIVALENCE RATIO
0.9 EQUIVALENCE RATIO
0.8 EQUIVALENCE RATIO
0.7 EQUIVALENCE RATIO
IN.MAN.PRESS. (m.bar)
1000
900
800
700
EXHAUST TEMP. (c)
550
500
450
400
EQUIV. RATIO
1.5
1.0
0.5
IGN.TIMING (BTDC)
40
30
20
10
E.G.R. RATE (%)
0
2
4
6
8
10
12
14
16

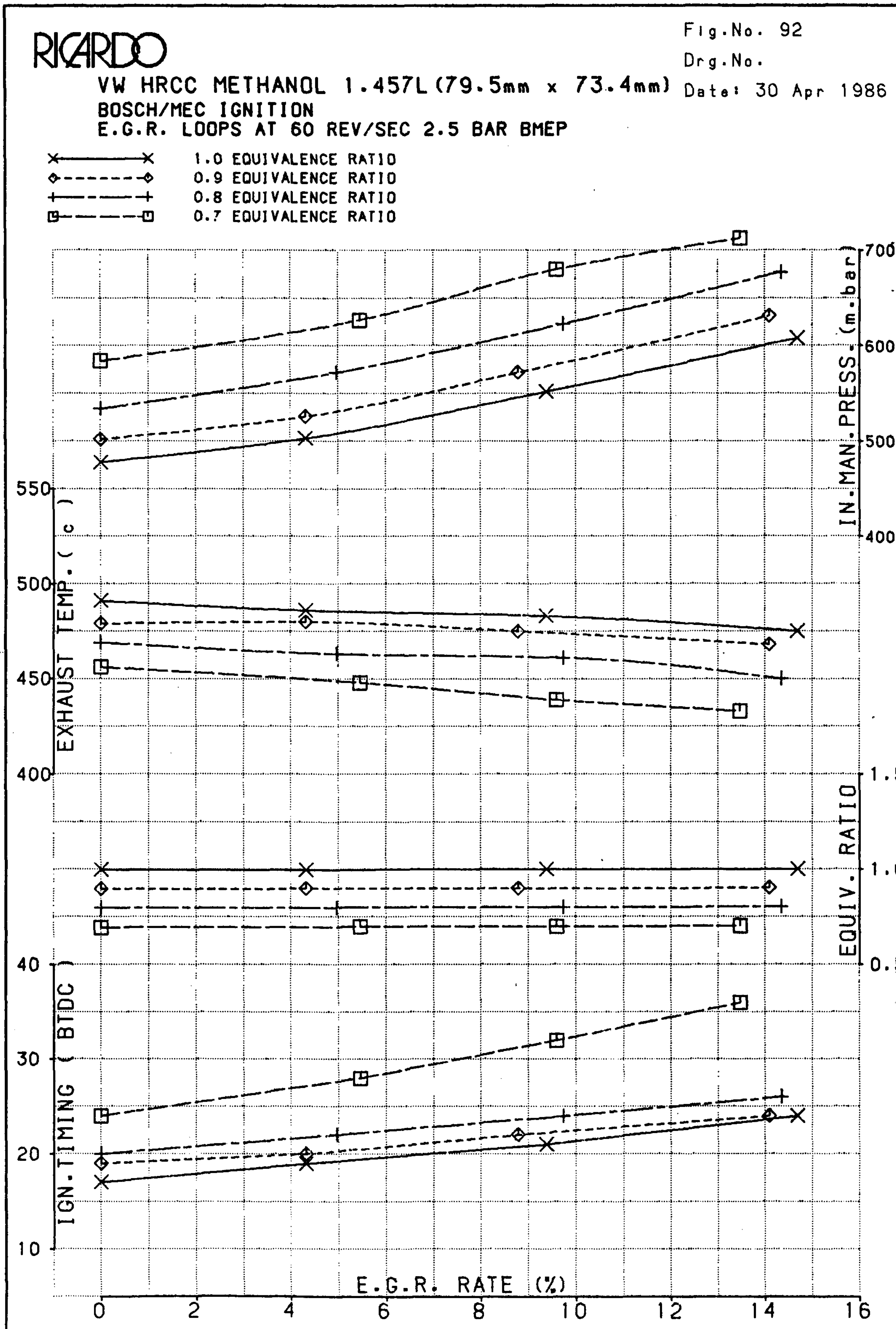


RICARDO
Fig.No. 89
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 40 REV/SEC 5.5 BAR BMEP
1.0 EQUIVALENCE RATIO
0.9 EQUIVALENCE RATIO
0.8 EQUIVALENCE RATIO
0.7 EQUIVALENCE RATIO
NOx (PPM)
CO (%)
HC (PPMc)
E.G.R. RATE (%)


RICARDO
Fig.No. 90
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 40 REV/SEC 5.5 BAR BMEP
1.0 EQUIVALENCE RATIO
0.9 EQUIVALENCE RATIO
0.8 EQUIVALENCE RATIO
0.7 EQUIVALENCE RATIO
HC+NOx (g/kW.h)
30
25
20
15
10
5
BRAKE THERMAL EFFICIENCY (%)
38
36
34
32
30
28
E.G.R. RATE (%)
0
2
4
6
8
10
12
14
16



RICARDO
Fig.No. 91
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 60 REV/SEC 2.5 BAR BMEP
1.0 EQUIVALENCE RATIO
0.9 EQUIVALENCE RATIO
0.8 EQUIVALENCE RATIO
0.7 EQUIVALENCE RATIO
NOx (g/kW.h)
CO (g/kW.h)
HC (g/kW.h)
BRAKE THERMAL EFF. (%)
E.G.R. RATE (%)
0
2
4
6
8
10
12
14
16



RICARDO
Fig.No. 92
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 60 REV/SEC 2.5 BAR BMEP
1.0 EQUIVALENCE RATIO
0.9 EQUIVALENCE RATIO
0.8 EQUIVALENCE RATIO
0.7 EQUIVALENCE RATIO
IN. MAN. PRESS. (m.bar)
EXHAUST TEMP. (c)
EQUIV. RATIO
IGN. TIMING (BTDC)
E.G.R. RATE (%)

RICARDO

Fig.No. 93

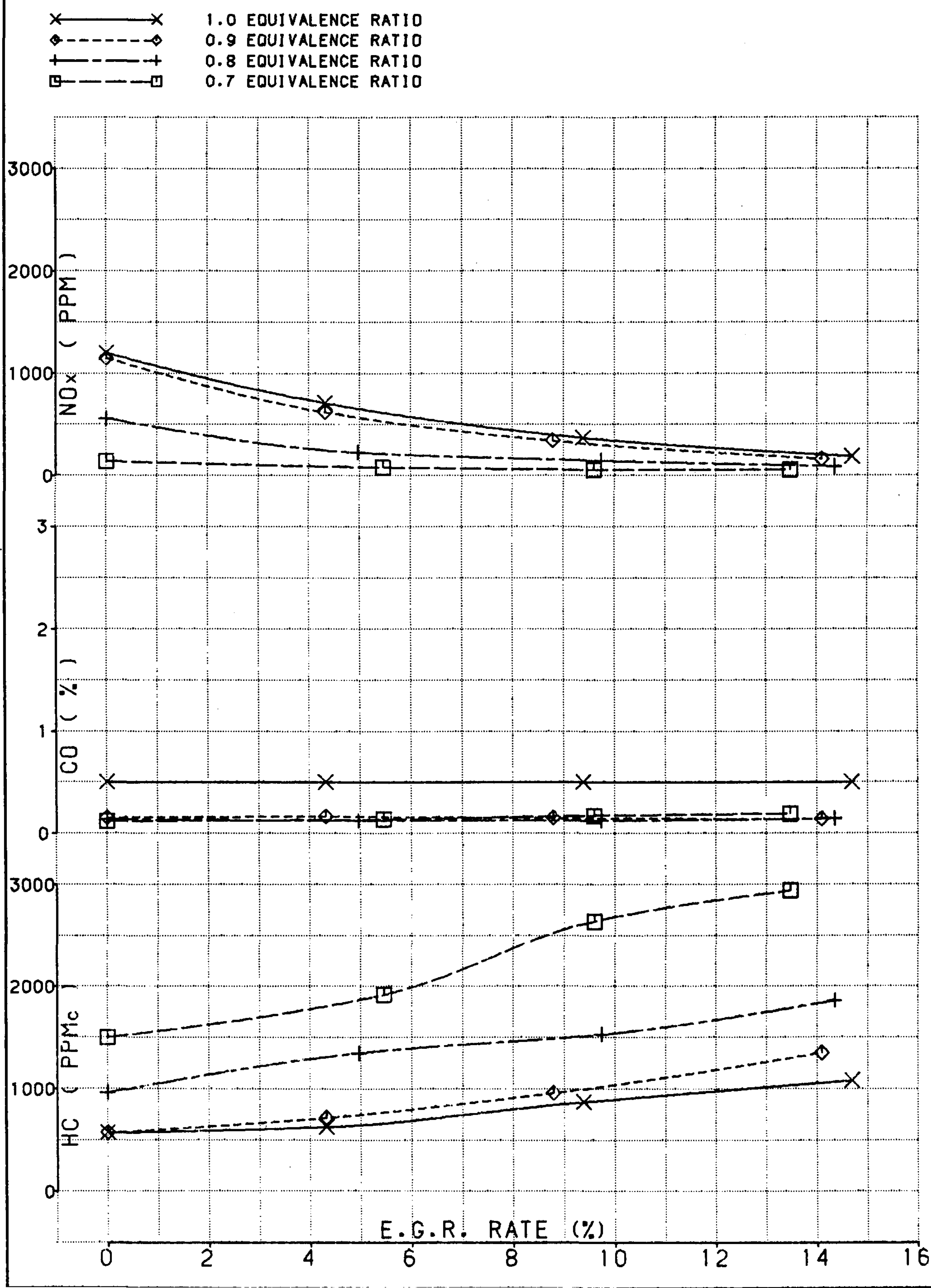
Drg.No.

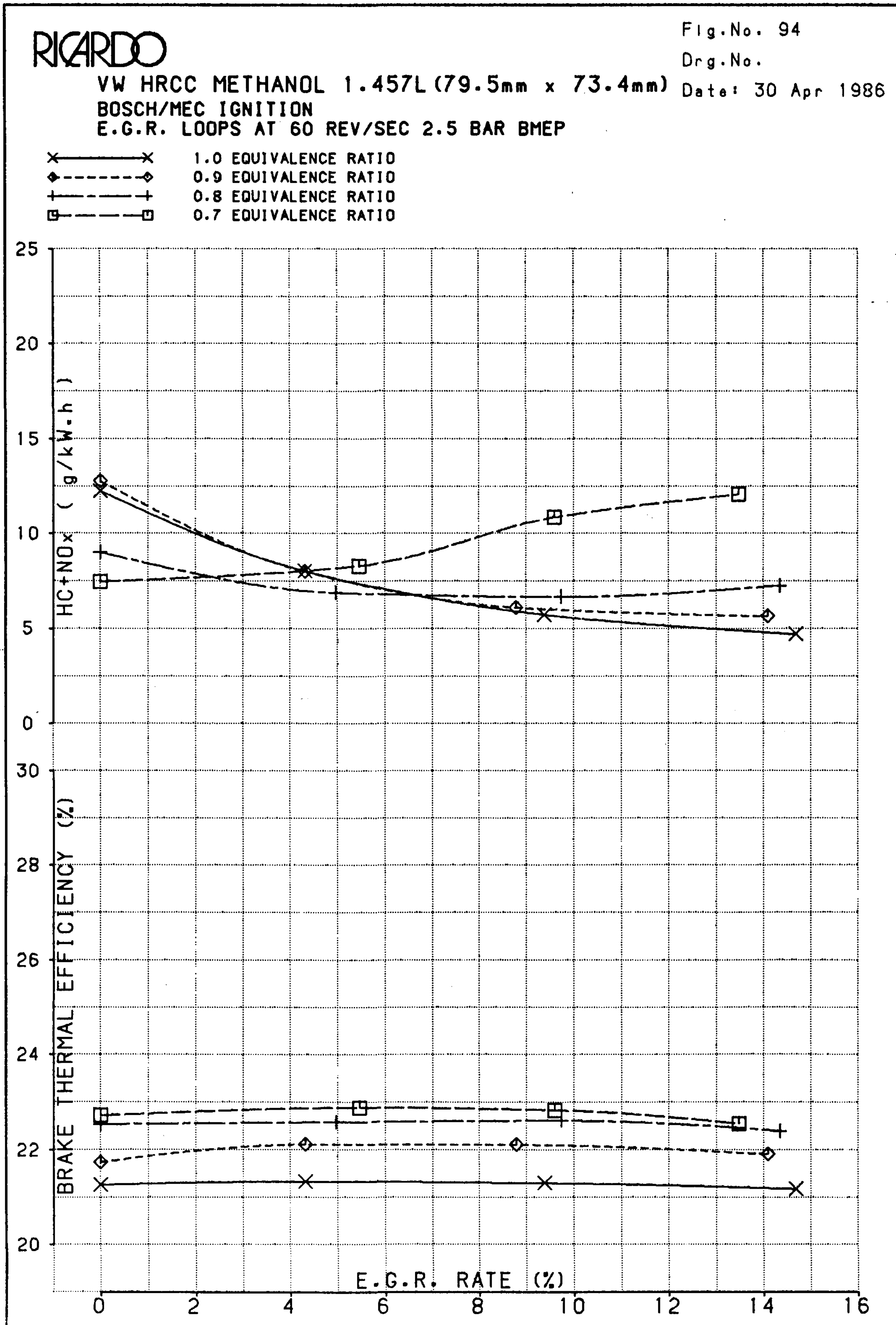
Date: 30 Apr 1986

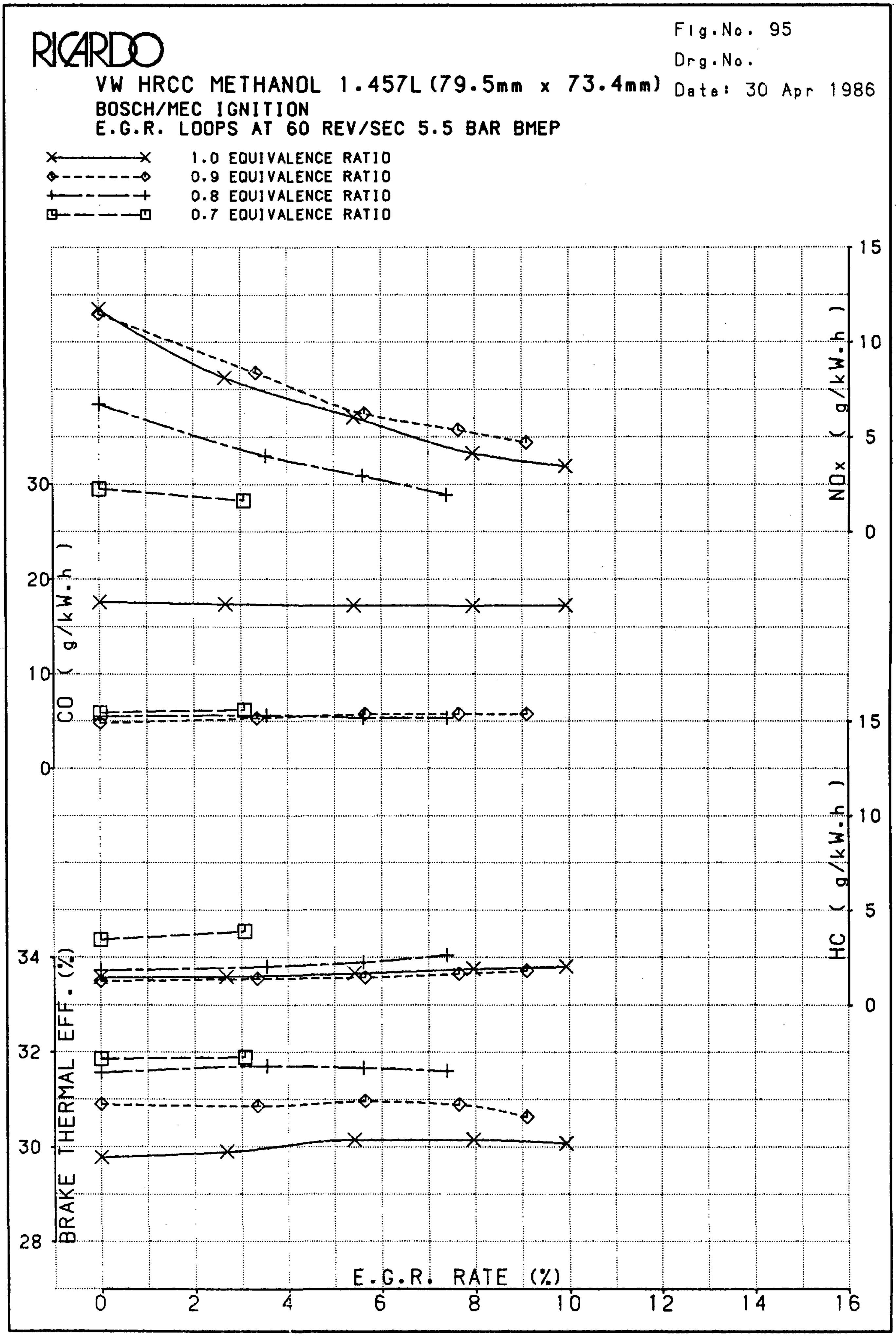
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

BOSCH/MEC IGNITION

E.G.R. LOOPS AT 60 REV/SEC 2.5 BAR BMEP

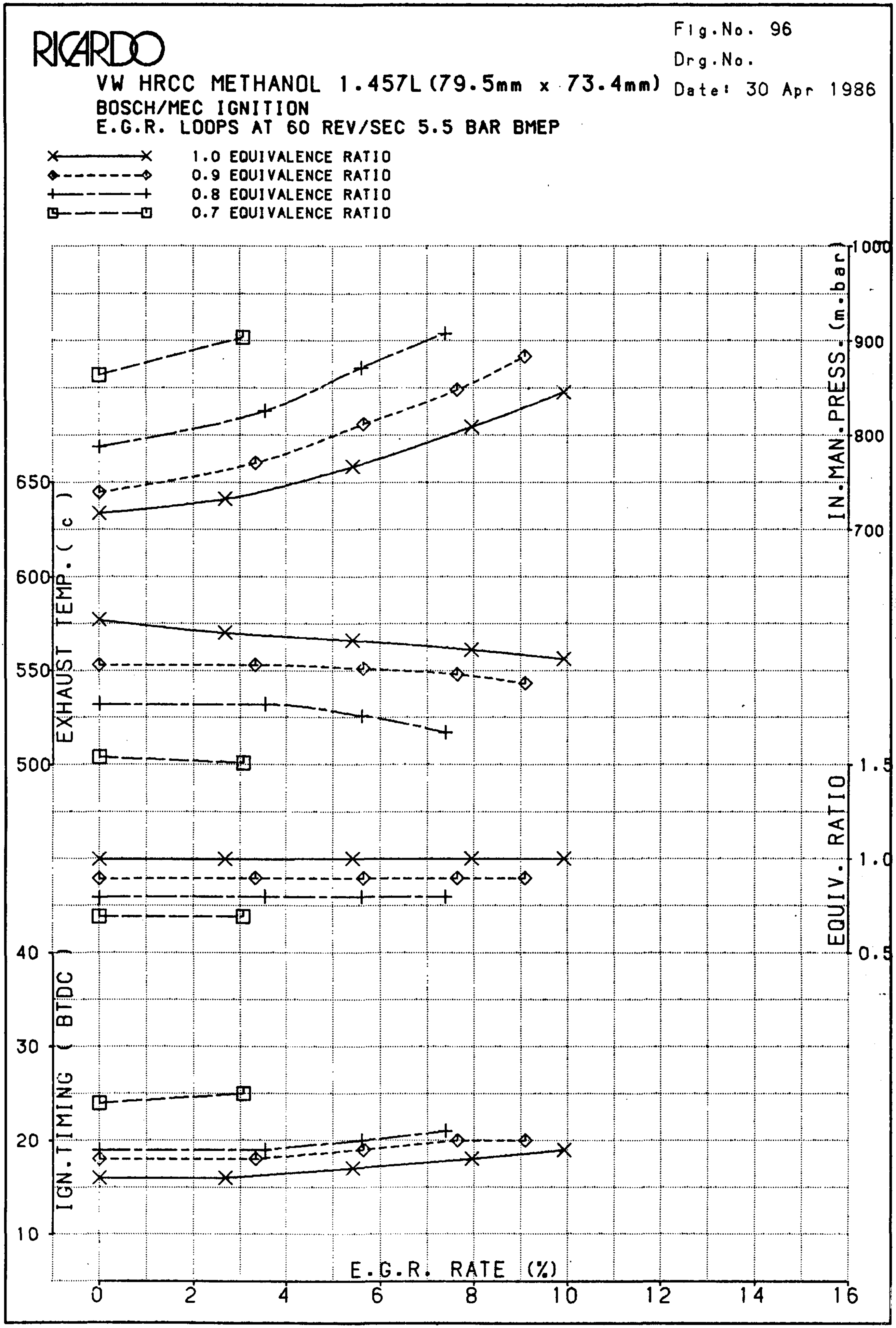



RICARDO
Fig.No. 94
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 60 REV/SEC 2.5 BAR BMEP
1.0 EQUIVALENCE RATIO
0.9 EQUIVALENCE RATIO
0.8 EQUIVALENCE RATIO
0.7 EQUIVALENCE RATIO
HC+NOx (g/kW.h)
BRAKE THERMAL EFFICIENCY (%)
E.G.R. RATE (%)
25
20
15
10
5
0
30
28
26
24
22
20
0
2
4
6
8
10
12
14
16



RICARDO
Fig.No. 95
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 60 REV/SEC 5.5 BAR BMEP
1.0 EQUIVALENCE RATIO
0.9 EQUIVALENCE RATIO
0.8 EQUIVALENCE RATIO
0.7 EQUIVALENCE RATIO
NOx (g/kW.h)
CO (g/kW.h)
HC (g/kW.h)
BRAKE THERMAL EFF. (%)
E.G.R. RATE (%)
0
2
4
6
8
10
12
14
16

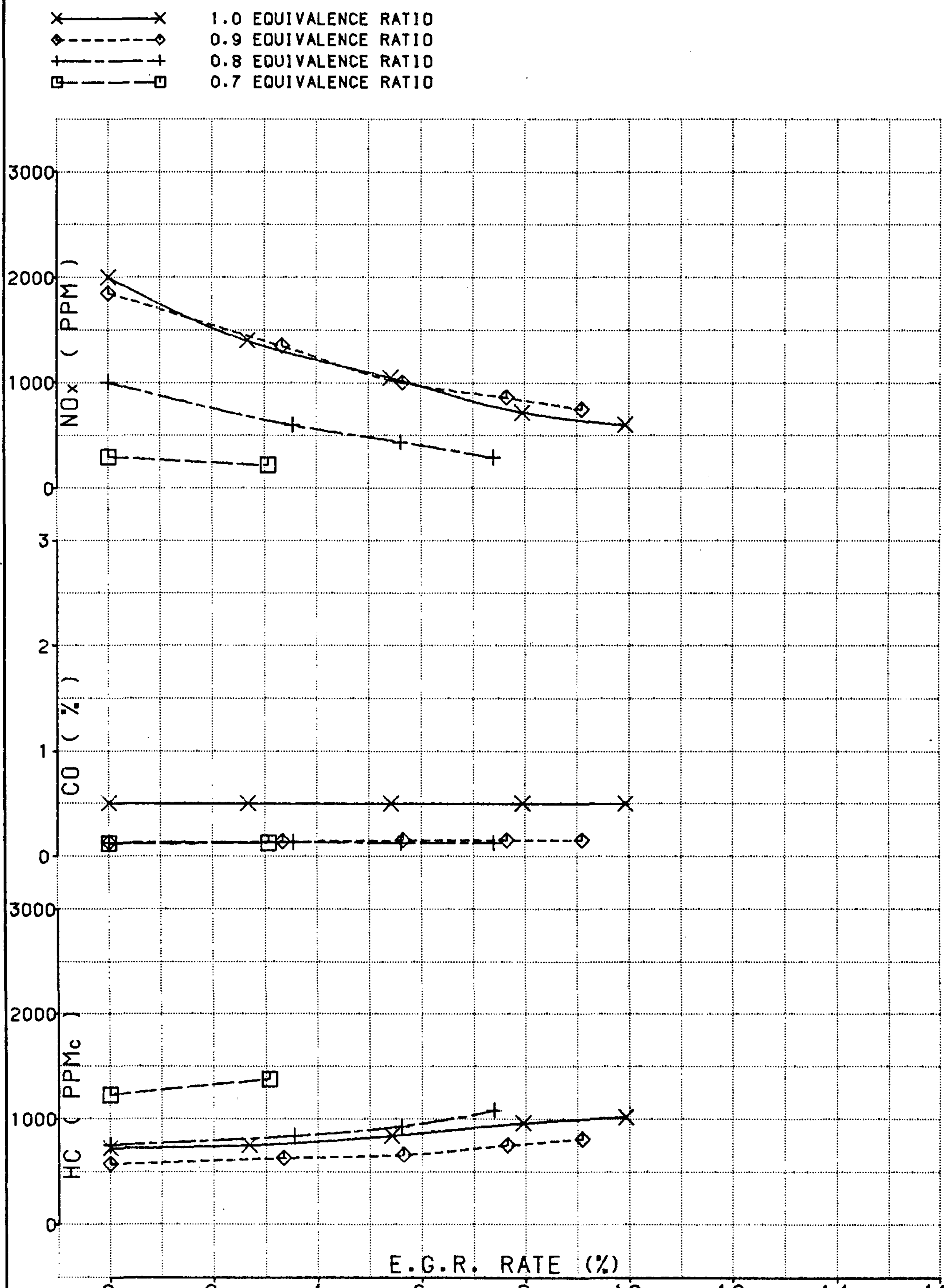
Fig.No. 96
Drg.No.
Date: 30 Apr 1986

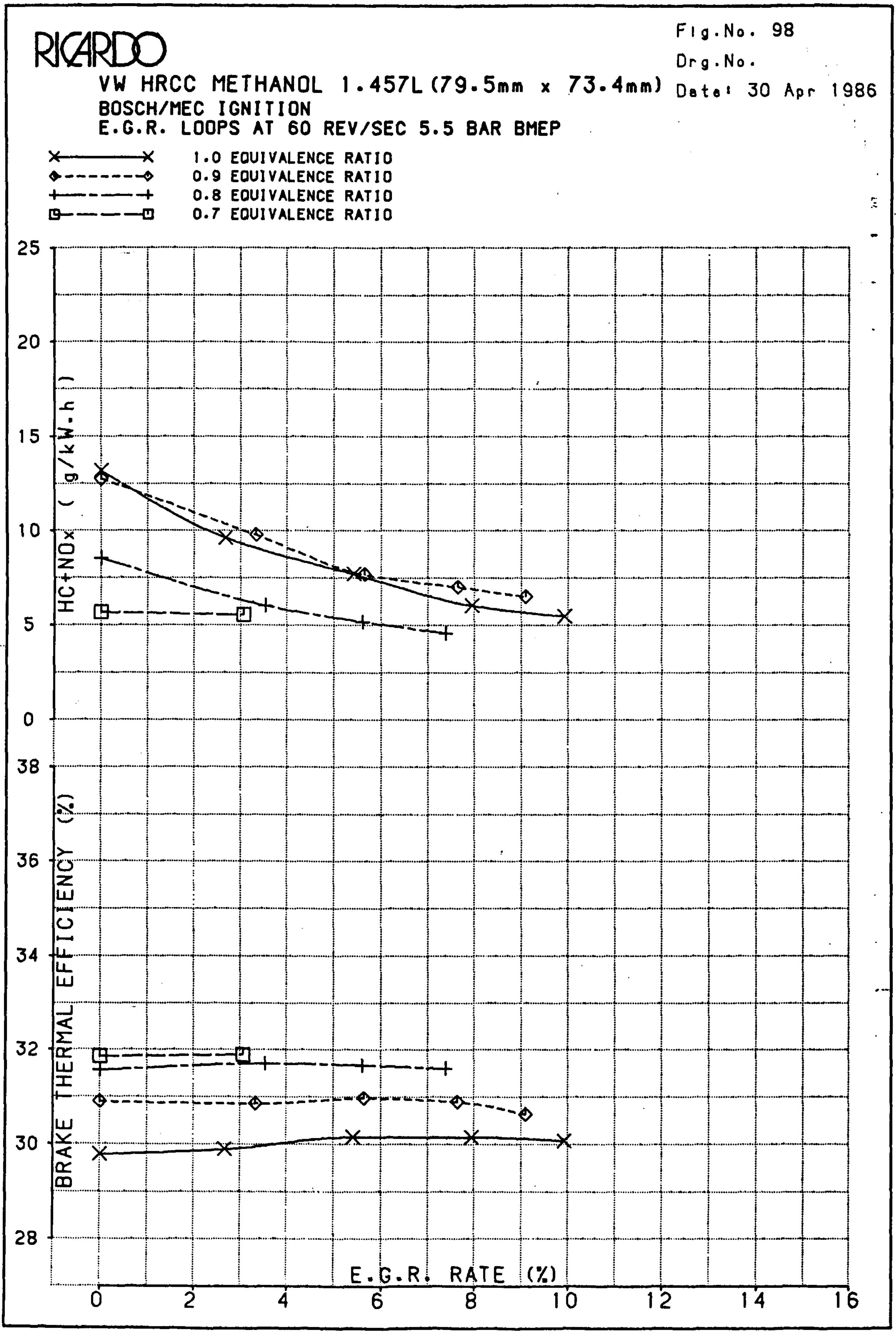


RICARDO

Fig.No. 97
Drg.No.
Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 60 REV/SEC 5.5 BAR BMEP





RICARDO
Fig.No. 98
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 60 REV/SEC 5.5 BAR BMEP
1.0 EQUIVALENCE RATIO
0.9 EQUIVALENCE RATIO
0.8 EQUIVALENCE RATIO
0.7 EQUIVALENCE RATIO
HC+NOx (g/kW.h)
BRAKE THERMAL EFFICIENCY (%)
E.G.R. RATE (%)
25
20
15
10
5
0
38
36
34
32
30
28
0
2
4
6
8
10
12
14
16

RICARDO

Fig.No. 99

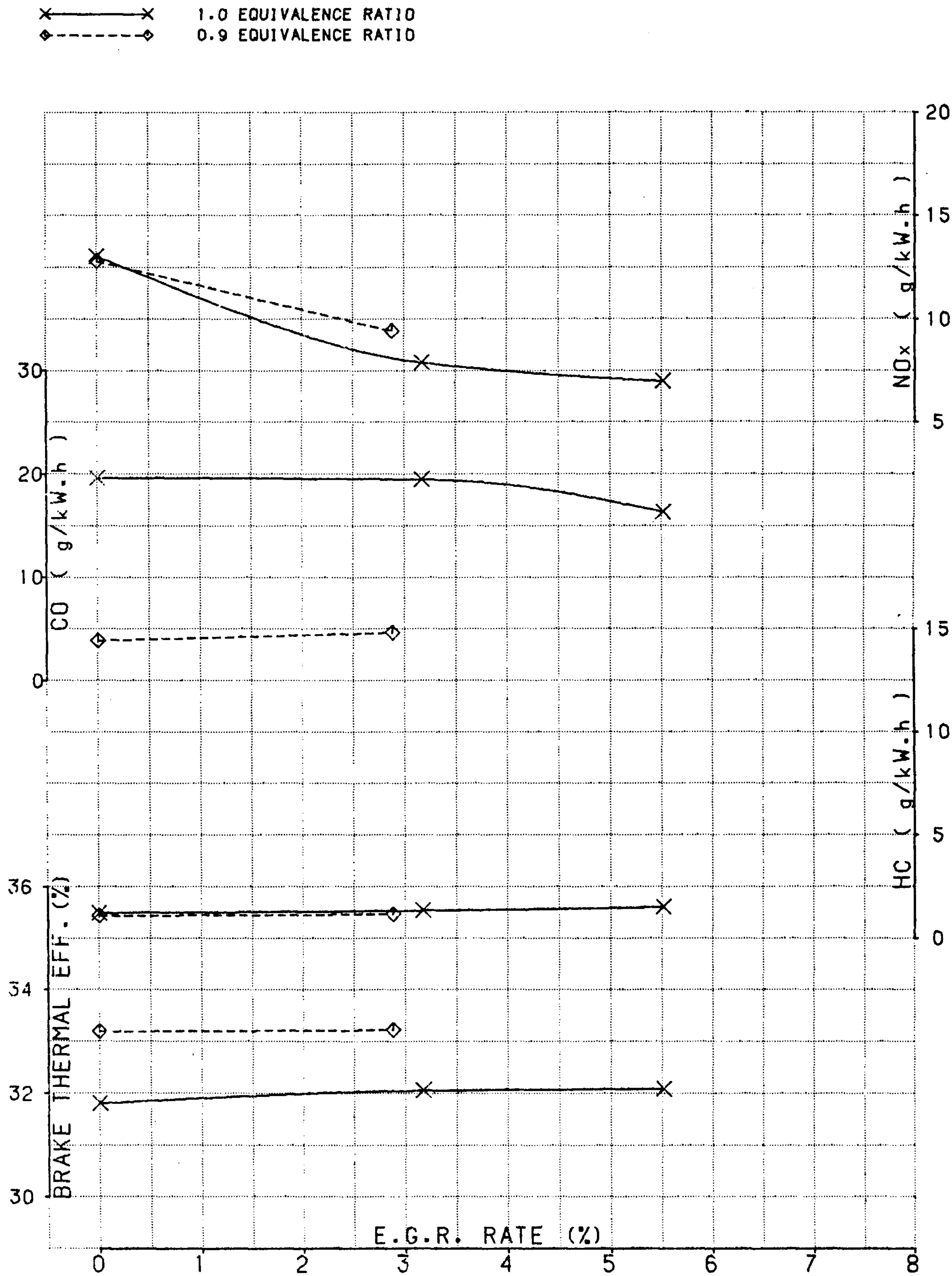
Drg.No.

Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

BOSCH/MEC IGNITION

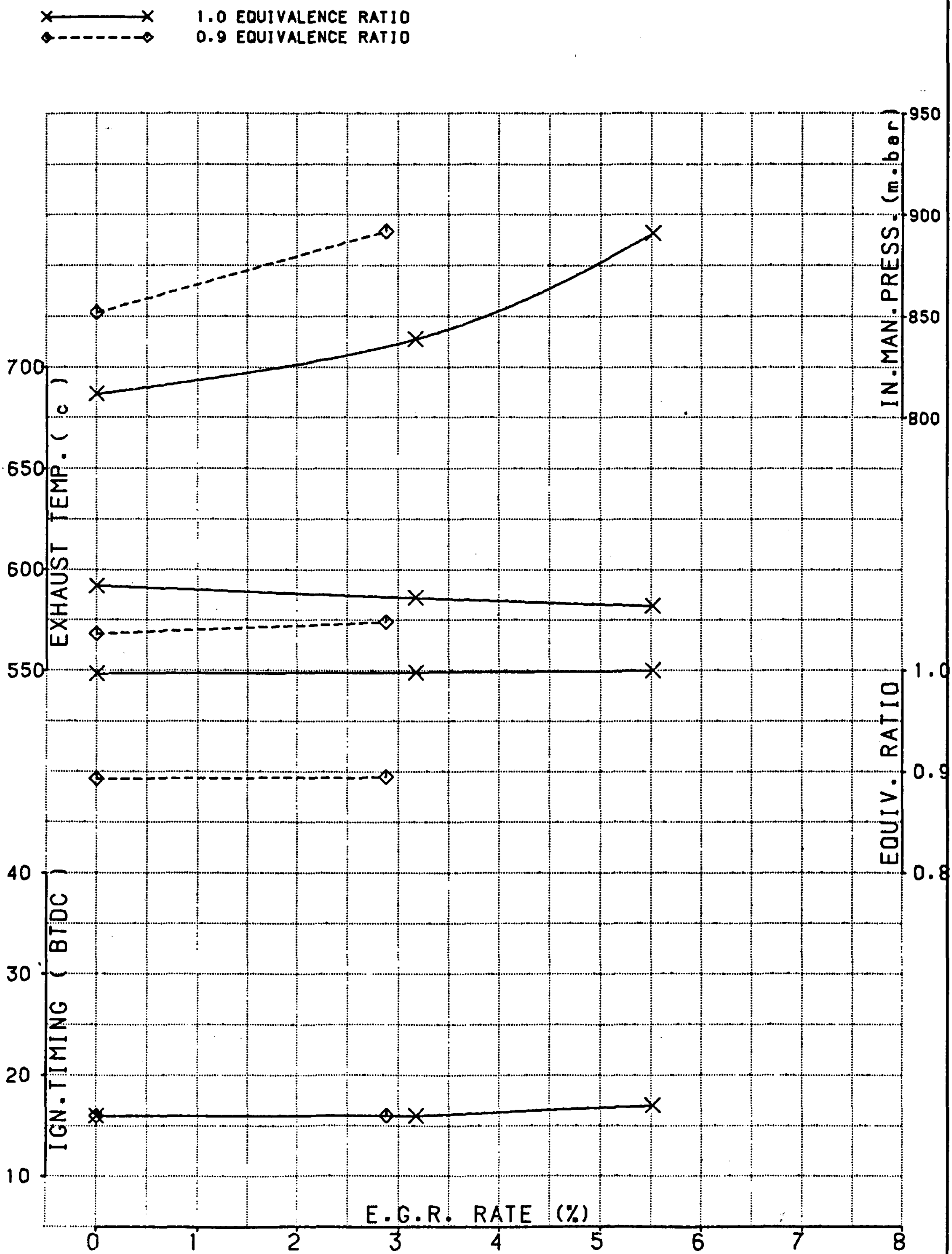
E.G.R. LOOPS AT 60 REV/SEC 7.0 BAR BMEP



RICARDO

Fig.No. 100
Drg.No.
Date: 30 Apr 1986

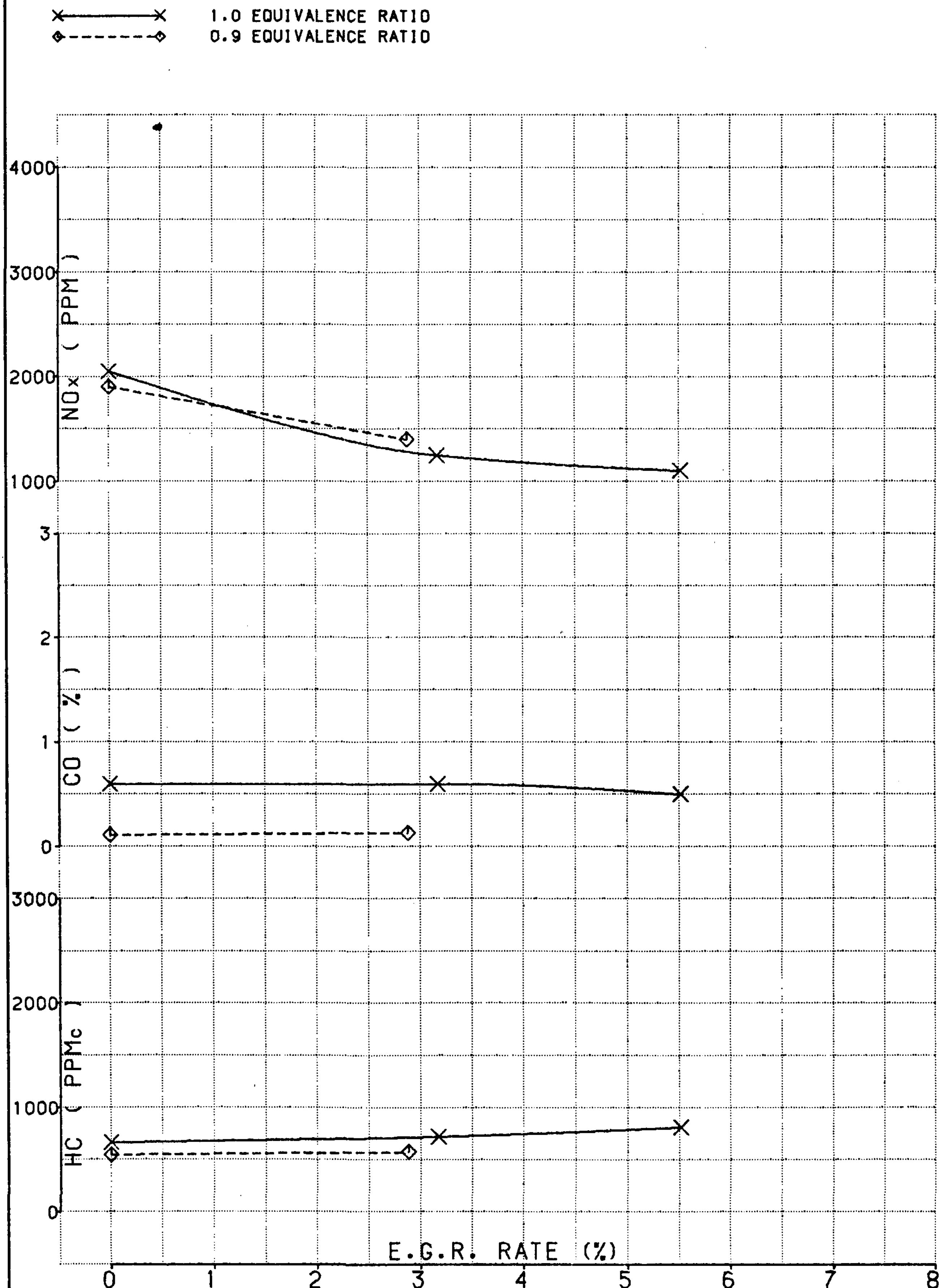
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 60 REV/SEC 7.0 BAR BMEP

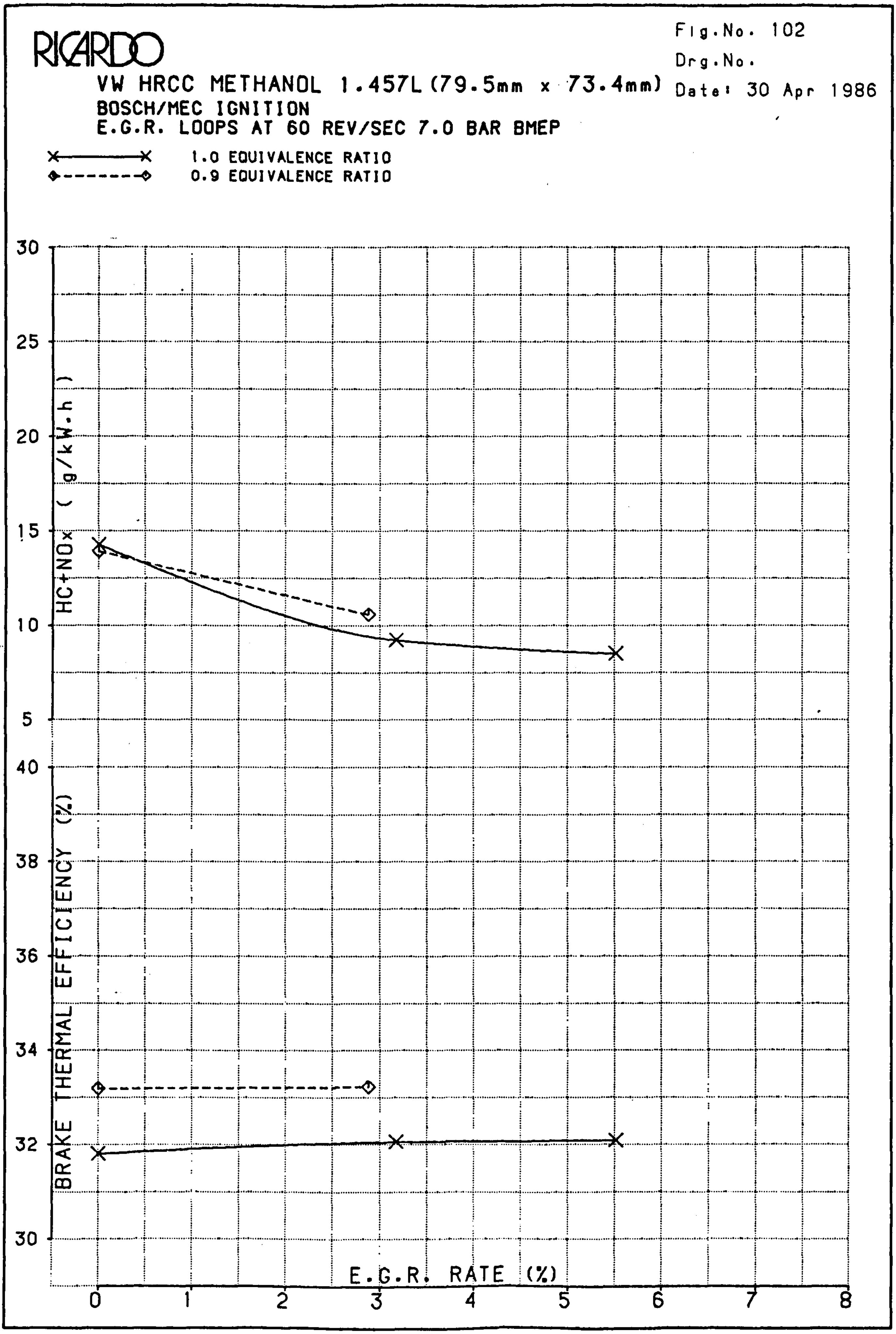


RICARDO

Fig.No. 101
Drg.No.
Date: 30 Apr 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 60 REV/SEC 7.0 BAR BMEP




RICARDO
Fig.No. 102
Drg.No.
Date: 30 Apr 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BOSCH/MEC IGNITION
E.G.R. LOOPS AT 60 REV/SEC 7.0 BAR BMEP
1.0 EQUIVALENCE RATIO
0.9 EQUIVALENCE RATIO
HC+NOx (g/kW.h)
BRAKE THERMAL EFFICIENCY (%)
E.G.R. RATE (%)
30
25
20
15
10
5
40
38
36
34
32
30
0
1
2
3
4
5
6
7
8

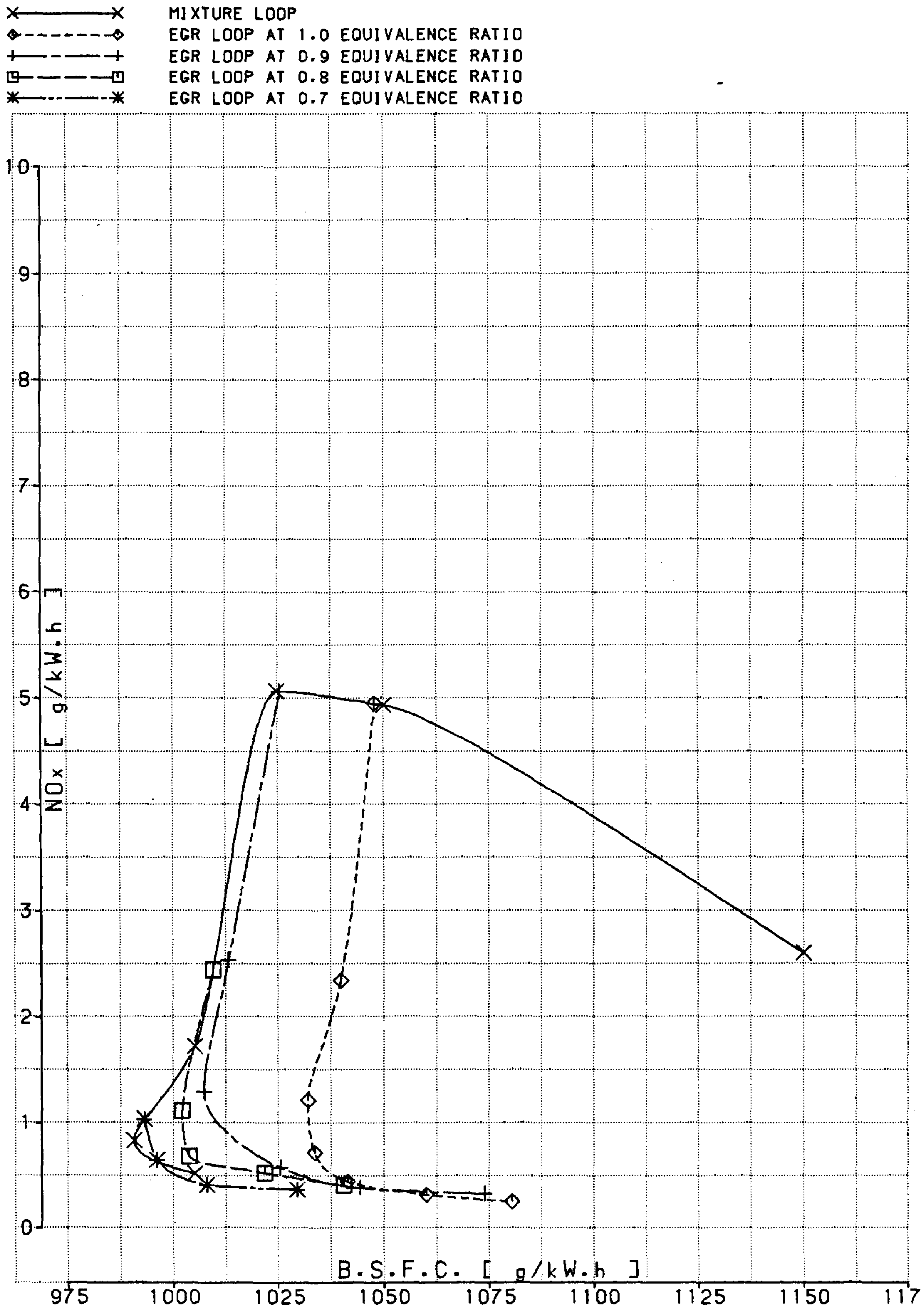
RICARDO

Fig.No. 103

Drg.No.

Date: 8 Oct 1986

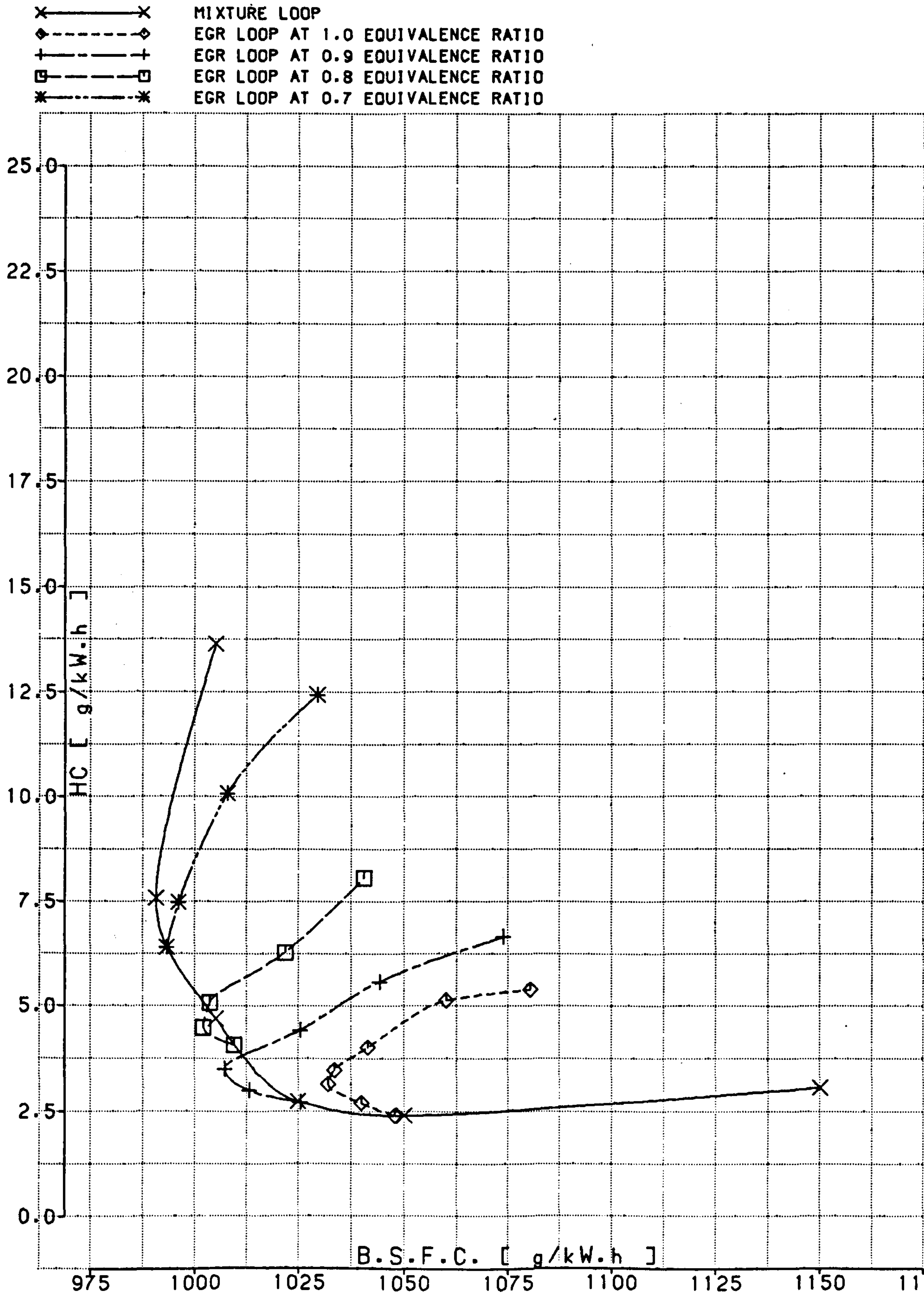
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BSFC AND EMISSIONS • TRADE-OFF GRAPHS
40 REV/SEC 1.5 BAR BMEP



RICARDO

Fig.No. 104
Drg.No.
Date: 8 Oct 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BSFC AND EMISSIONS * TRADE-OFF GRAPHS
40 REV/SEC 1.5 BAR BMEP



RICARDO

Fig.No. 105

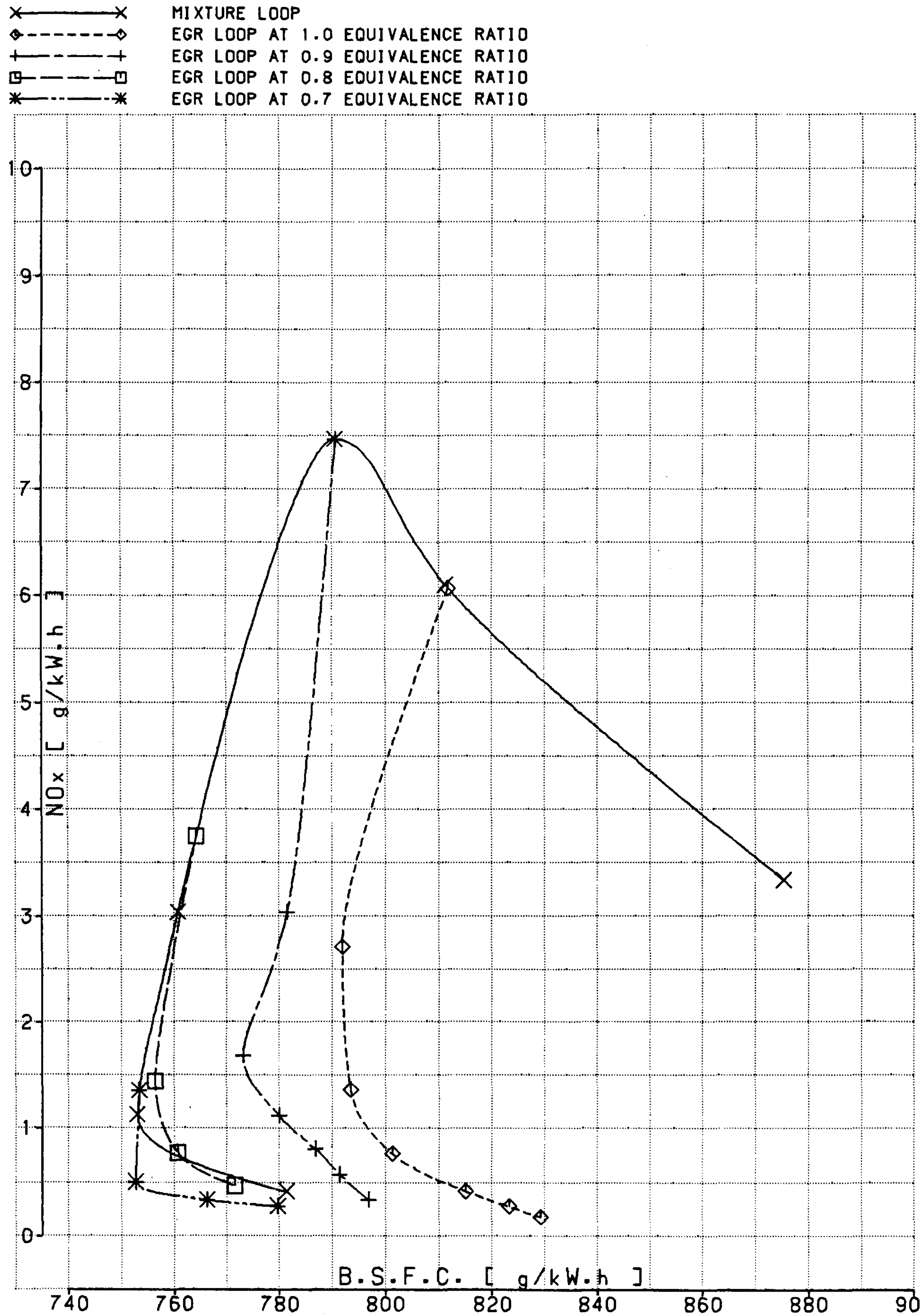
Drg.No.

Date: 8 Oct 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

BSFC AND EMISSIONS * TRADE-OFF GRAPHS

40 REV/SEC 2.5 BAR BMEP



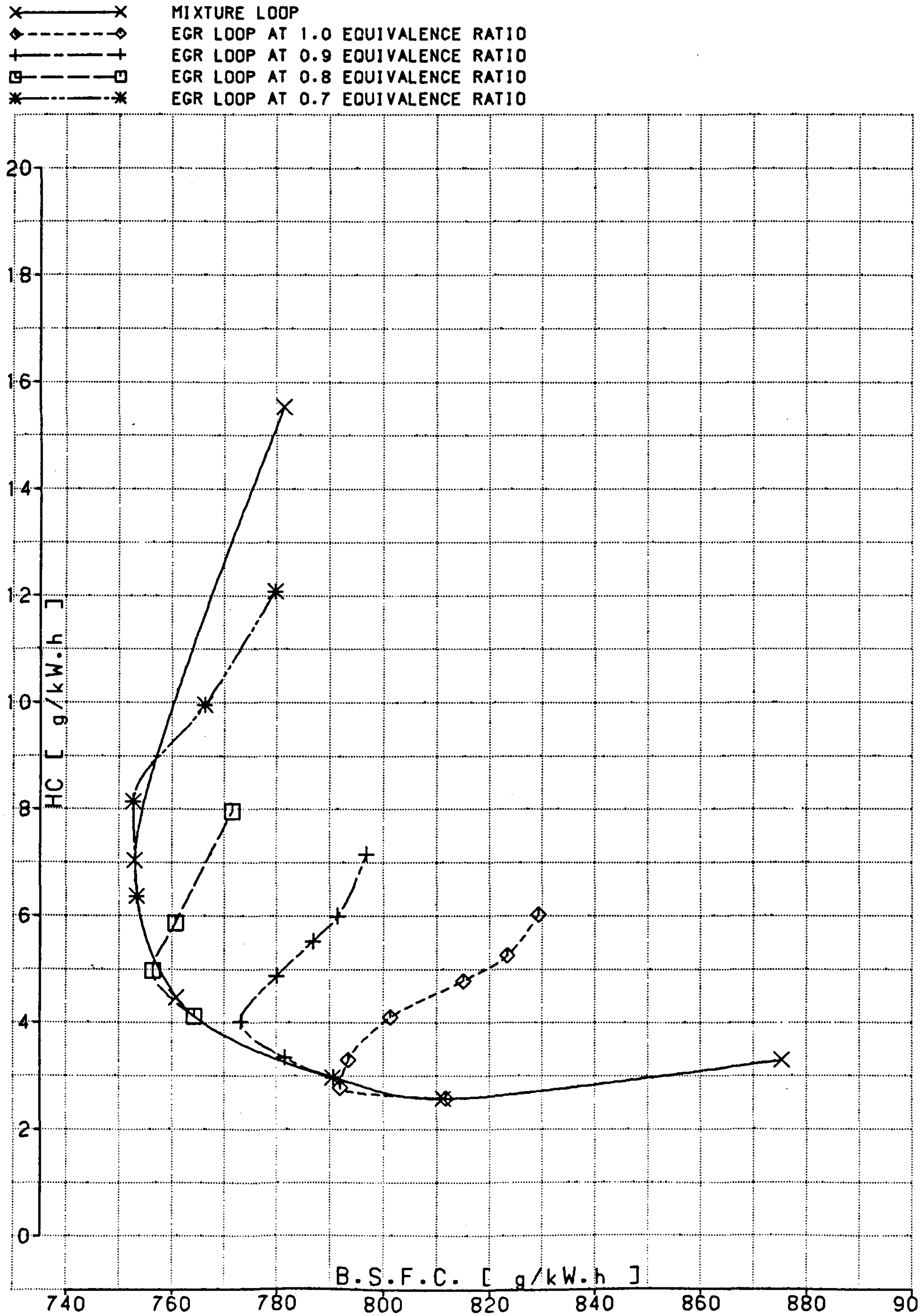
RICARDO

Fig.No. 106

Drg.No.

Date: 8 Oct 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BSFC AND EMISSIONS • TRADE-OFF GRAPHS
40 REV/SEC 2.5 BAR BMEP



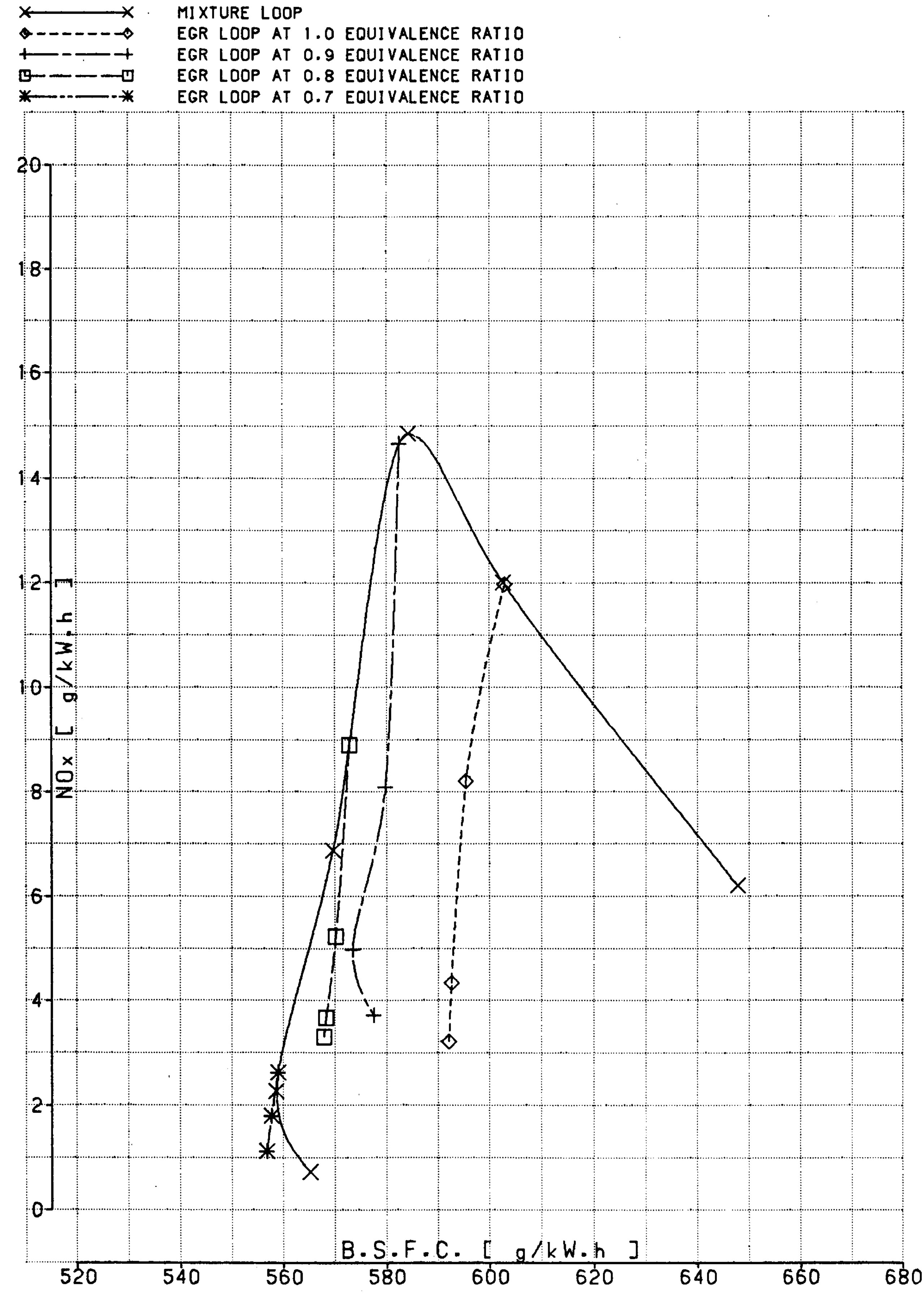
RICARDO

Fig.No. 107

Drg.No.

Date: 8 Oct 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BSFC AND EMISSIONS * TRADE-OFF GRAPHS
40 REV/SEC 5.5 BAR BMEP



RICARDO

Fig.No. 108

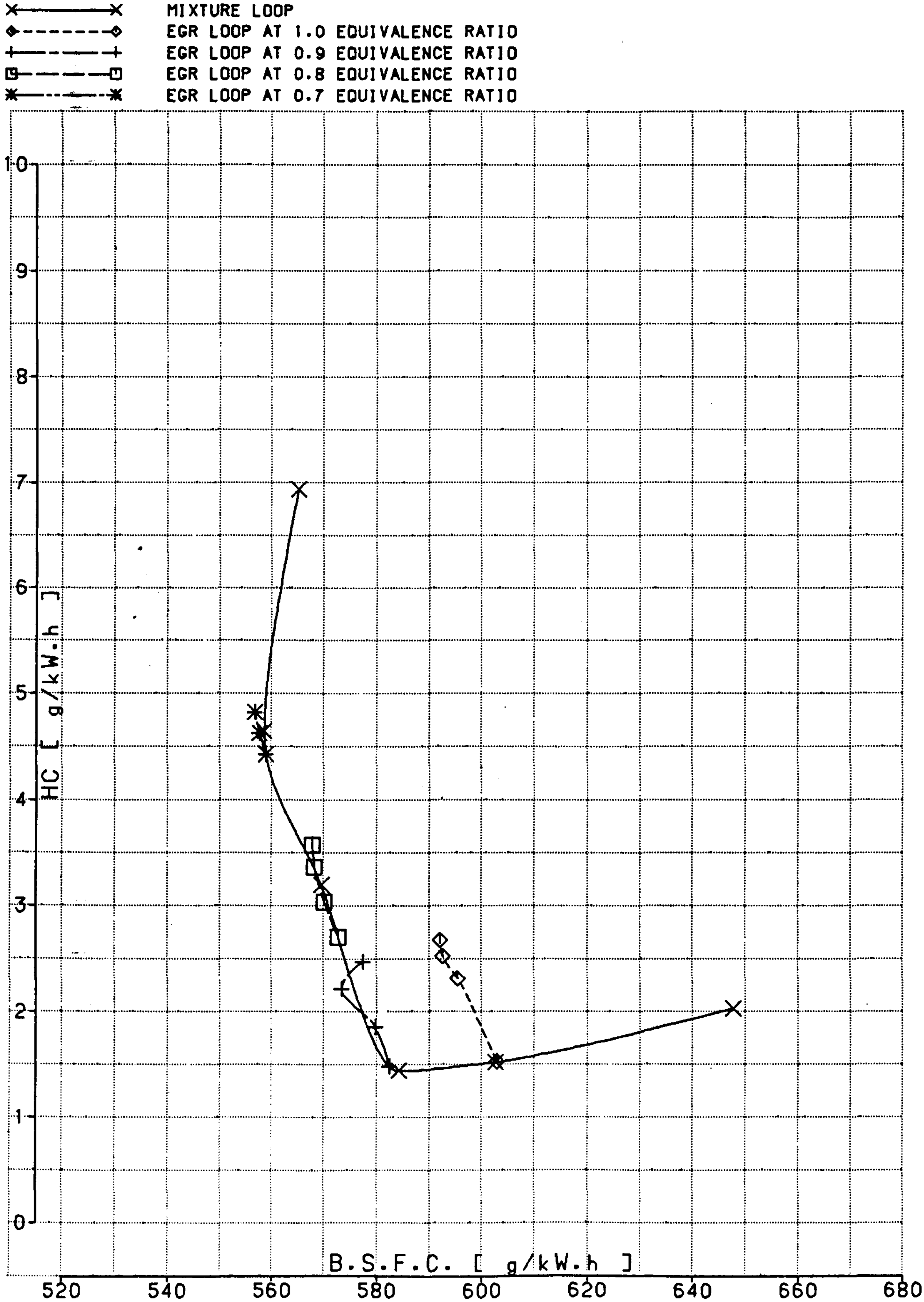
Drg.No.

Date: 8 Oct 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

BSFC AND EMISSIONS • TRADE-OFF GRAPHS

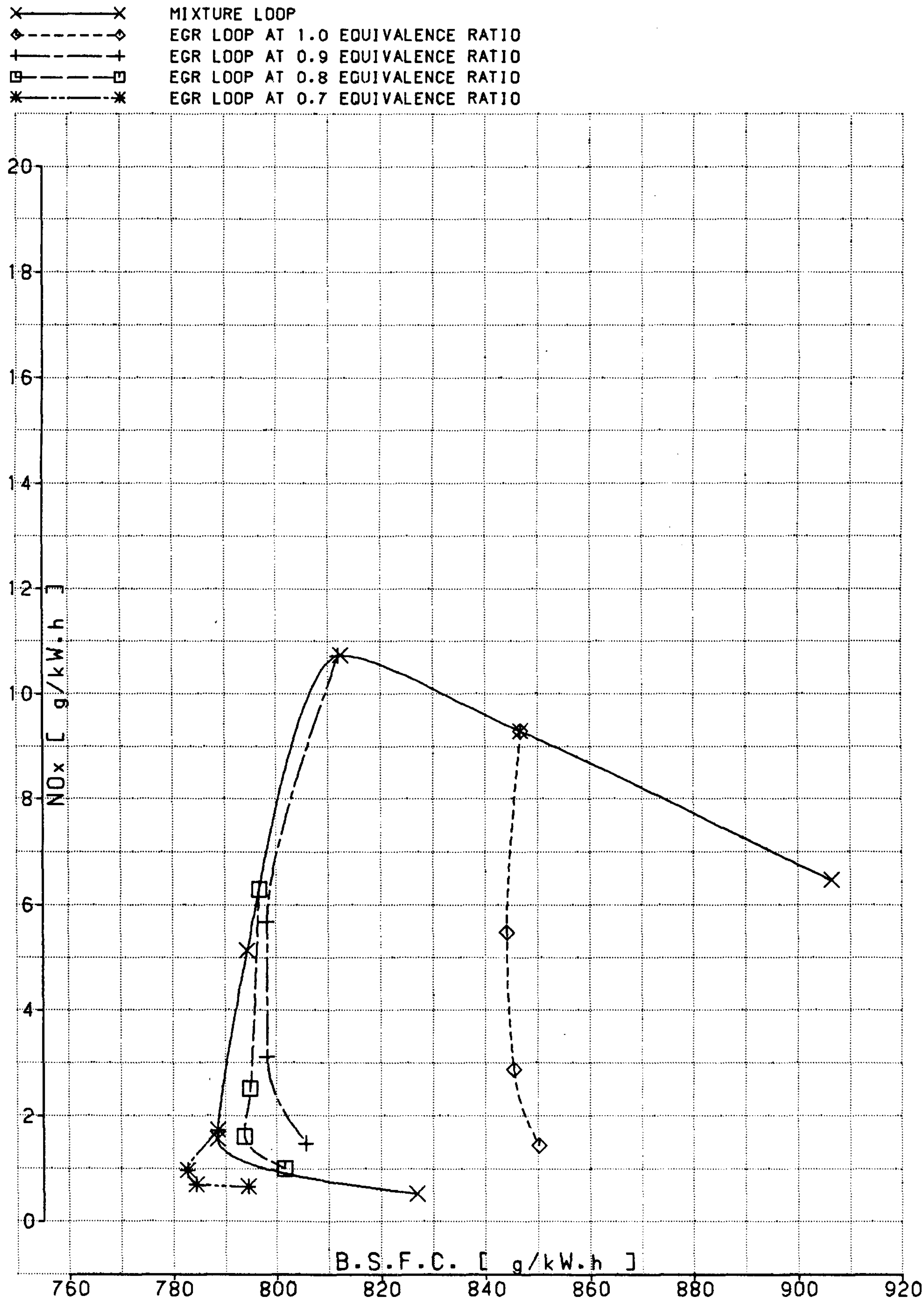
40 REV/SEC 5.5 BAR BMEP



RICARDO

Fig.No. 109
Drg.No.
Date: 8 Oct 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BSFC AND EMISSIONS • TRADE-OFF GRAPHS
60 REV/SEC 2.5 BAR BMEP



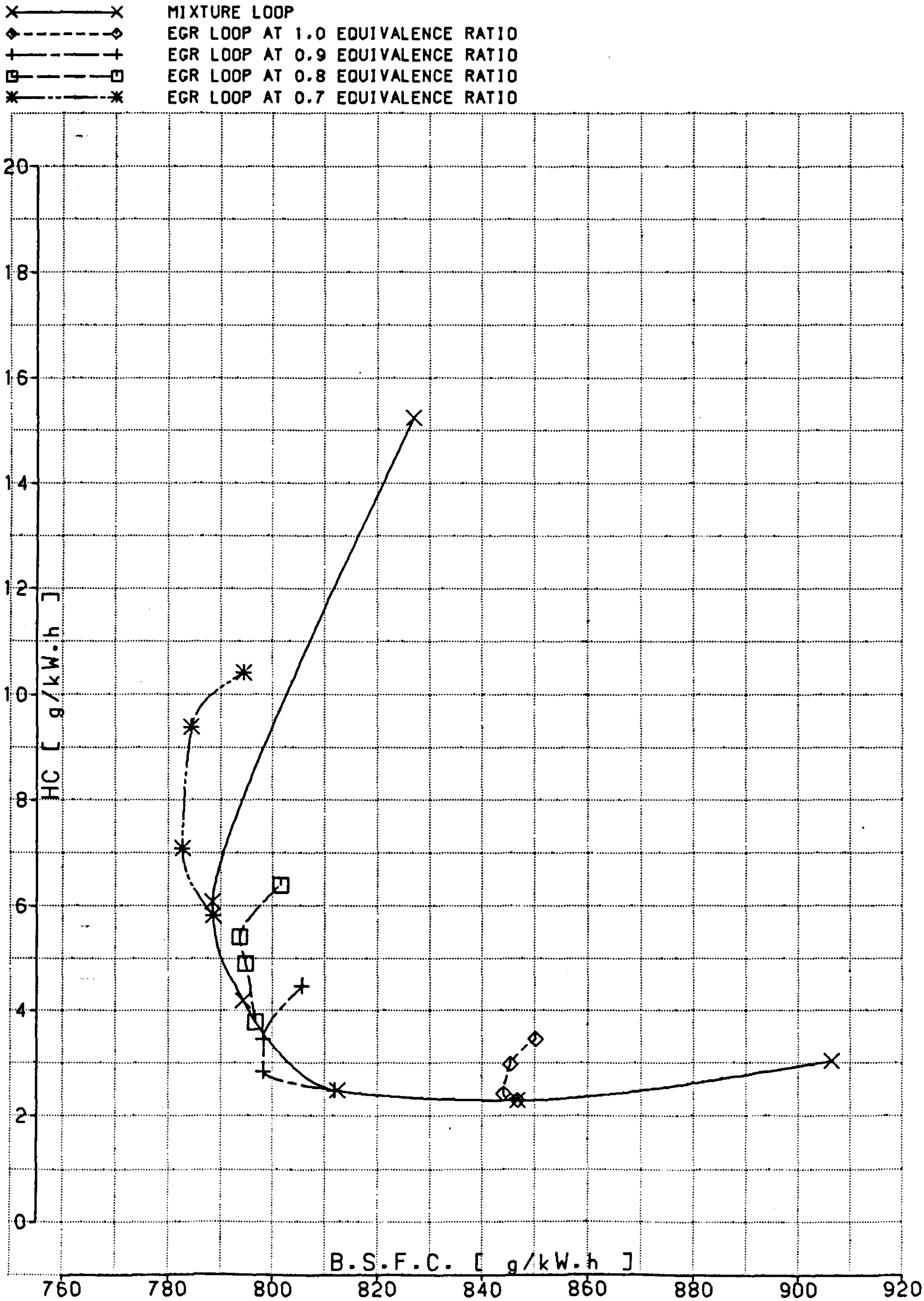
RICARDO

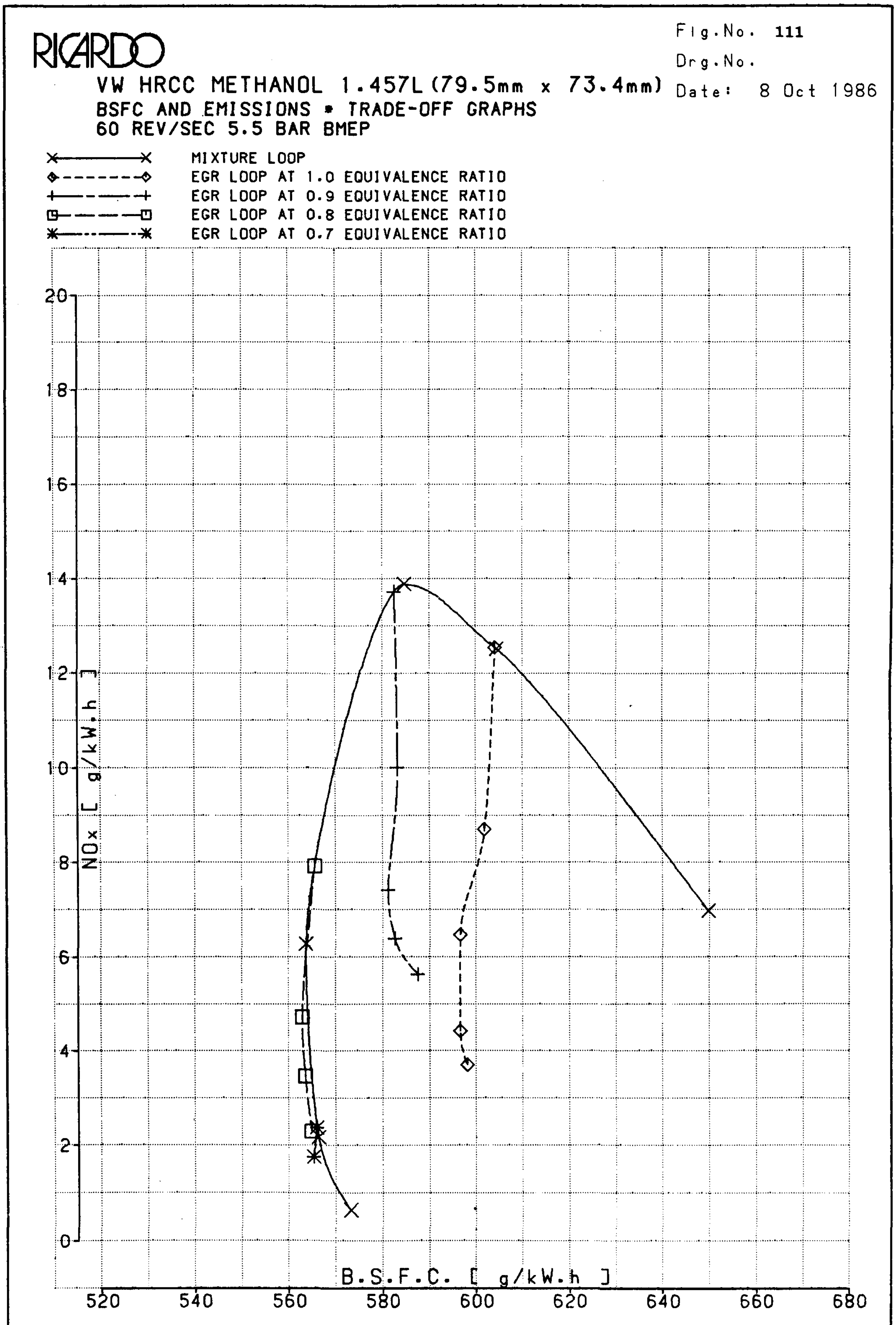
Fig.No. 110

Drg.No.

Date: 8 Oct 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BSFC AND EMISSIONS • TRADE-OFF GRAPHS
60 REV/SEC 2.5 BAR BMEP





RICARDO
Fig.No. 111
Drg.No.
Date: 8 Oct 1986
VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)
BSFC AND EMISSIONS * TRADE-OFF GRAPHS
60 REV/SEC 5.5 BAR BMEP
MIXTURE LOOP
EGR LOOP AT 1.0 EQUIVALENCE RATIO
EGR LOOP AT 0.9 EQUIVALENCE RATIO
EGR LOOP AT 0.8 EQUIVALENCE RATIO
EGR LOOP AT 0.7 EQUIVALENCE RATIO
NOx [g/kW.h]
0
2
4
6
8
10
12
14
16
18
20
B.S.F.C. [g/kW.h]
520
540
560
580
600
620
640
660
680

RICARDO

Fig.No. 112

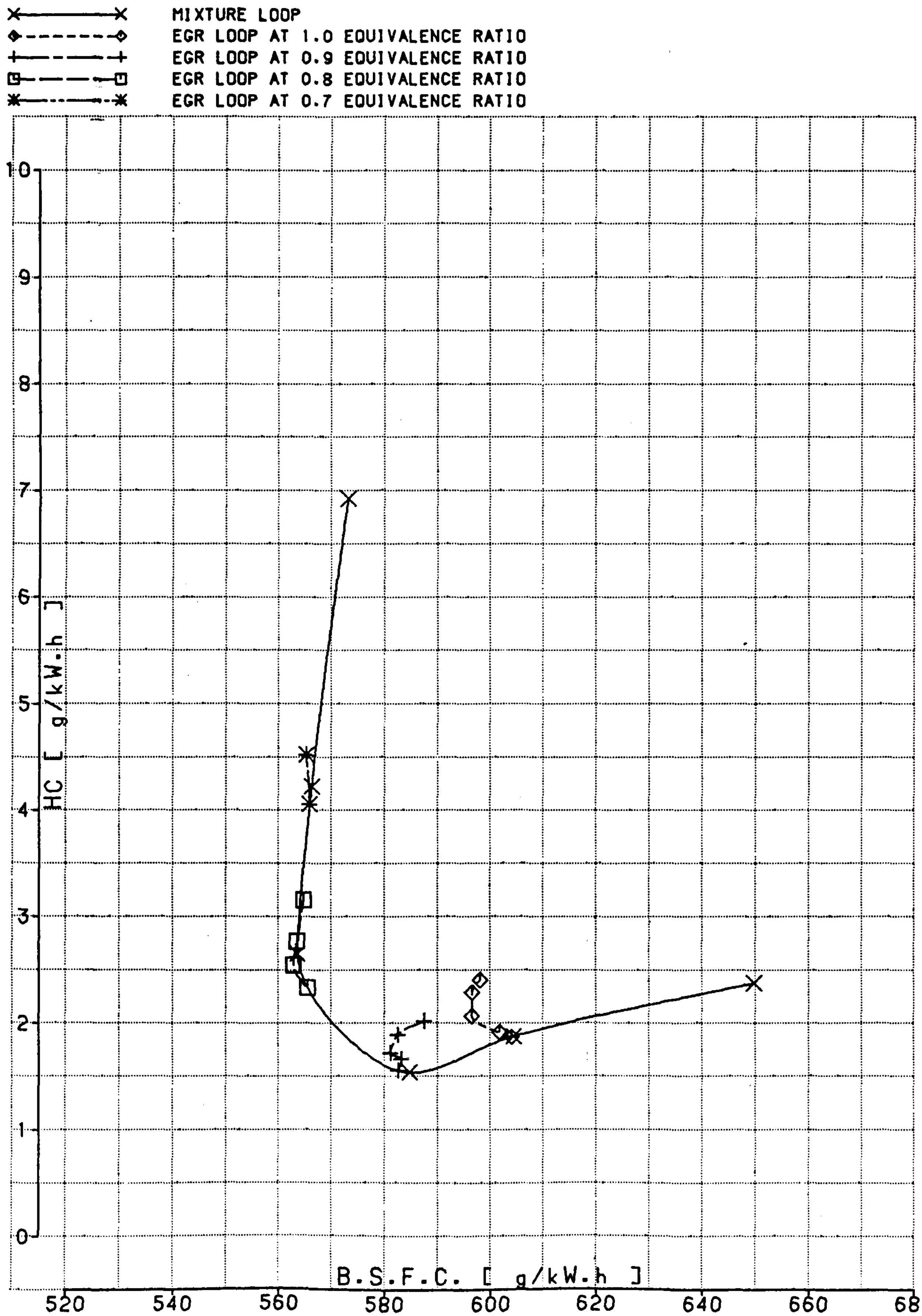
Drg.No.

Date: 8 Oct 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

BSFC AND EMISSIONS • TRADE-OFF GRAPHS

60 REV/SEC 5.5 BAR BMEP



RICARDO

Fig.No. 113

Drg.No.

Date: 8 Oct 1986

VW HRCC METHANOL 1.457L (79.5mm x 73.4mm)

BSFC AND EMISSIONS * TRADE-OFF GRAPHS

60 REV/SEC 7.0 BAR BMEP

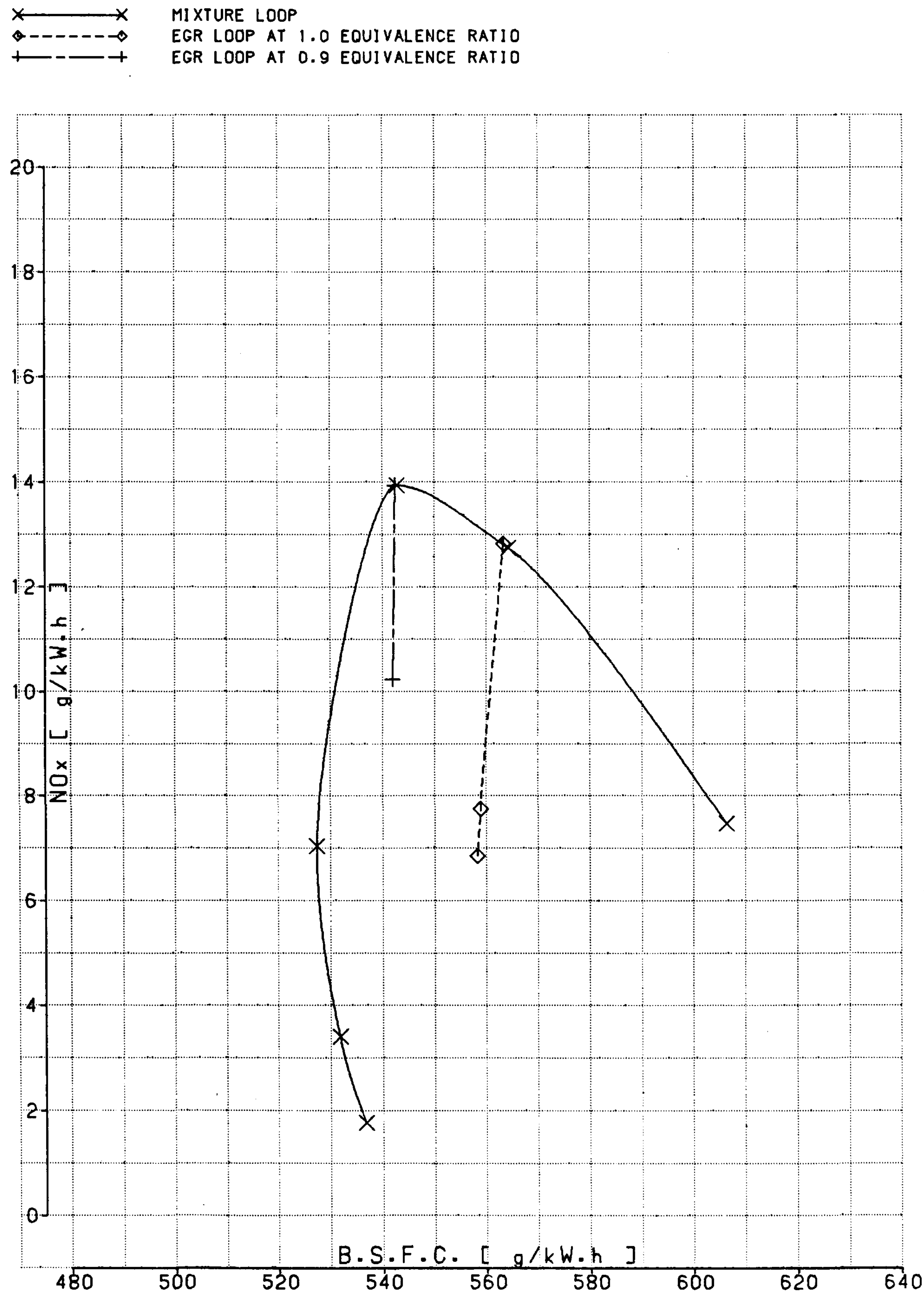
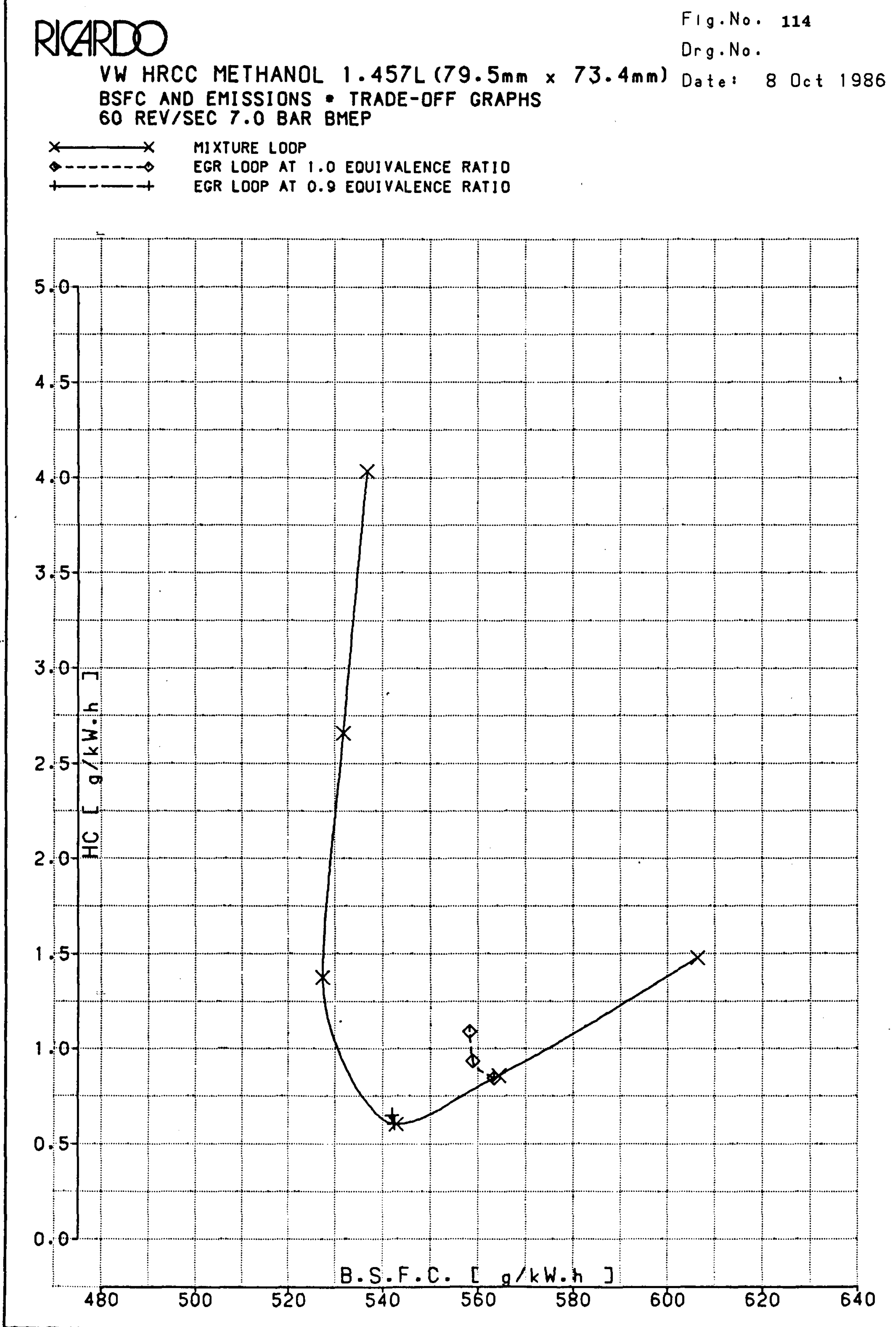


Fig.No. 114

Drg.No.

Date: 8 Oct 1986



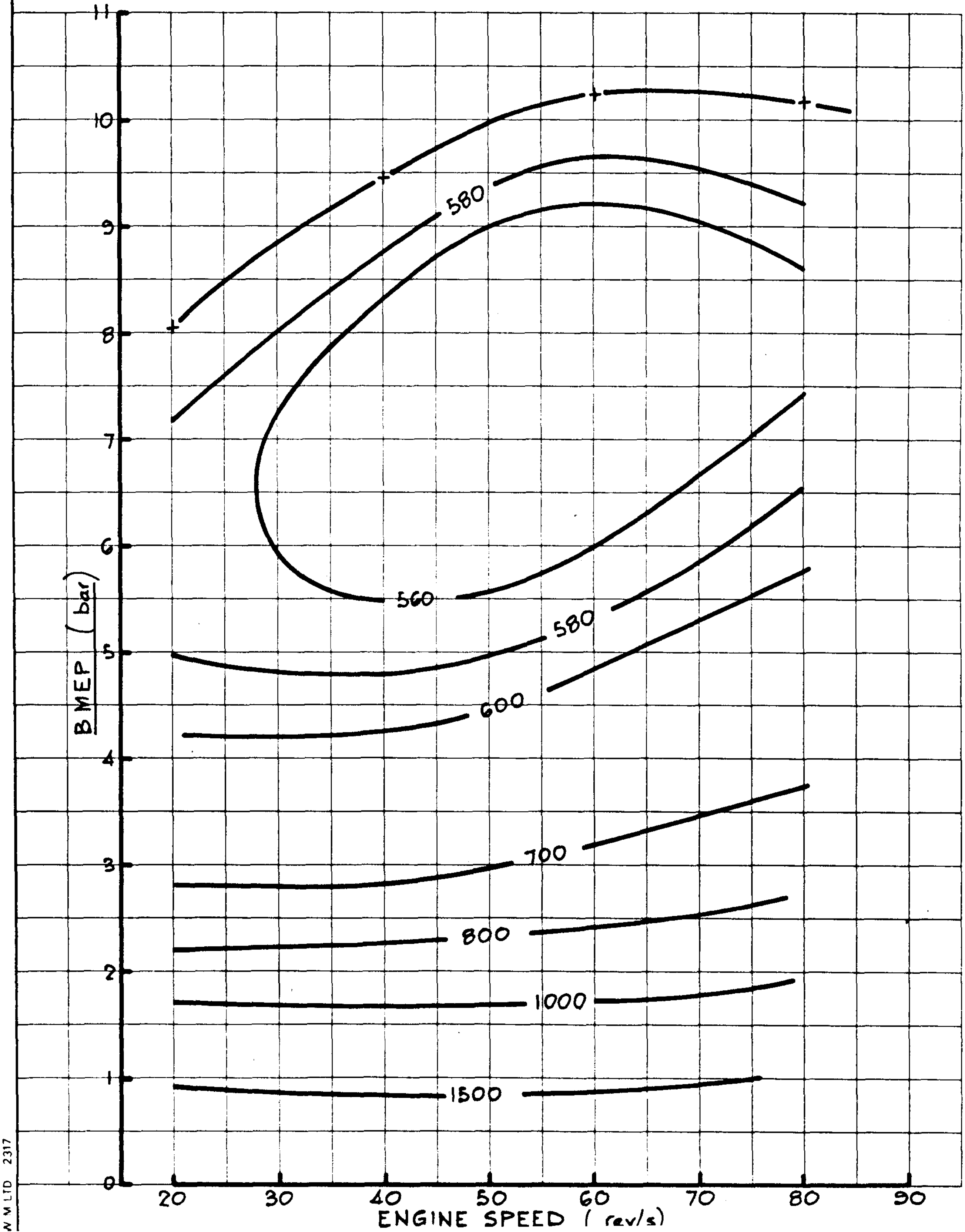
GL/BF

RICARDO

FIG. No. 115
Drg. No. D.56226
Date FEB. '86

VW HRCC METHANOL 1·457l (79·5 mm x 73·4 mm)
ENGINE MAPPING - BSFC CONTOURS (g/kW.h)
M.E.C. AUTO FUELLING / AUTO IGNITION - NO EGR

BEST ECONOMY - MBT IGNITION TIMING STRATEGY



W M LTD 2317

RICARDO

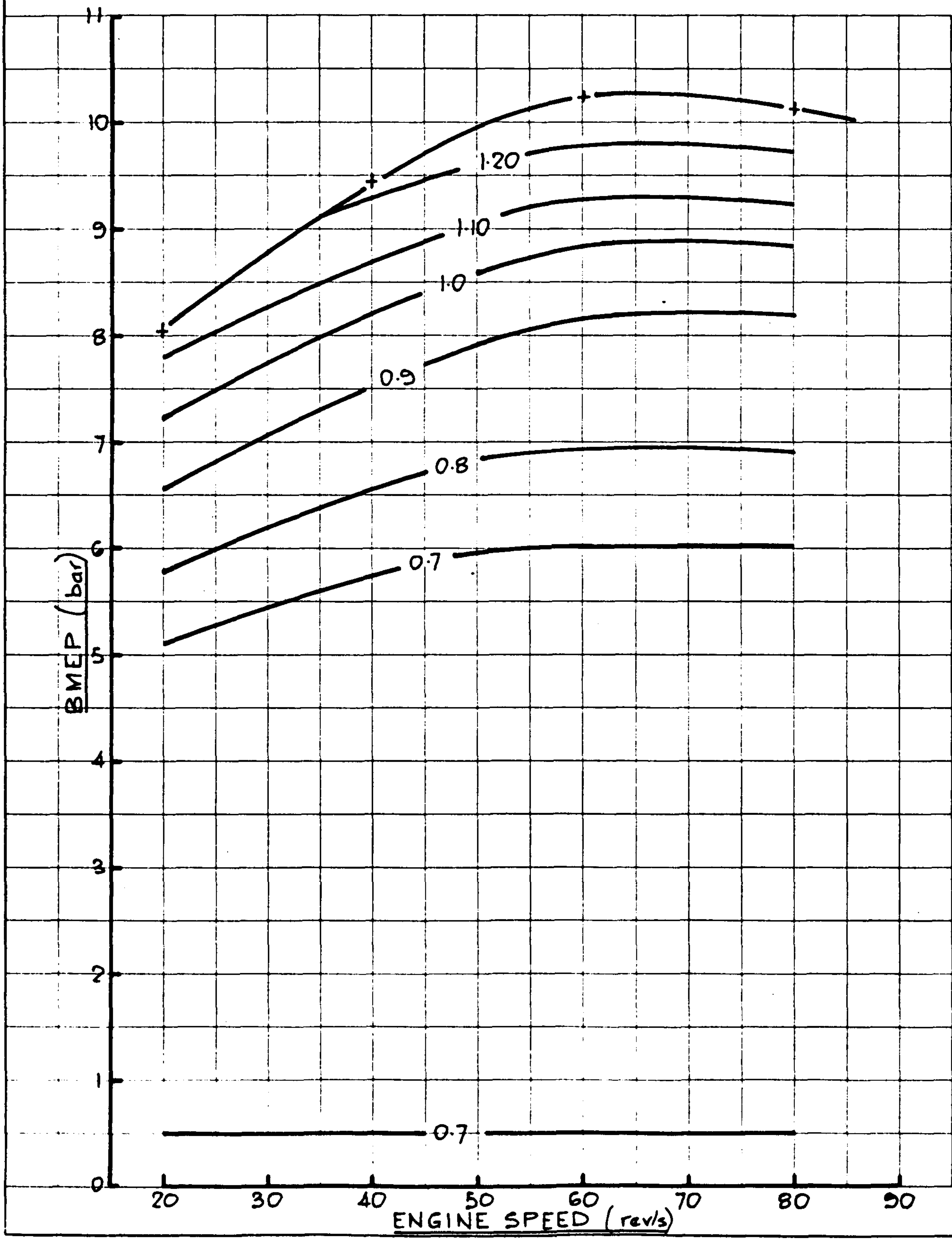
FIG. No. 116
Drg. No. D56247
Date FEB. '86

VW HRCC METHANOL 1·457ℓ (79·5 mm x 73·4 mm)

ENGINE MAPPING - EQUIVALENCE RATIO CONTOURS

M.E.C. AUTO FUELLING / AUTO IGNITION - NO EGR

BEST ECONOMY - MBT IGNITION TIMING STRATEGY



GL/BF

RICARDO

FIG. No. 117

Drg. No. D. 56227

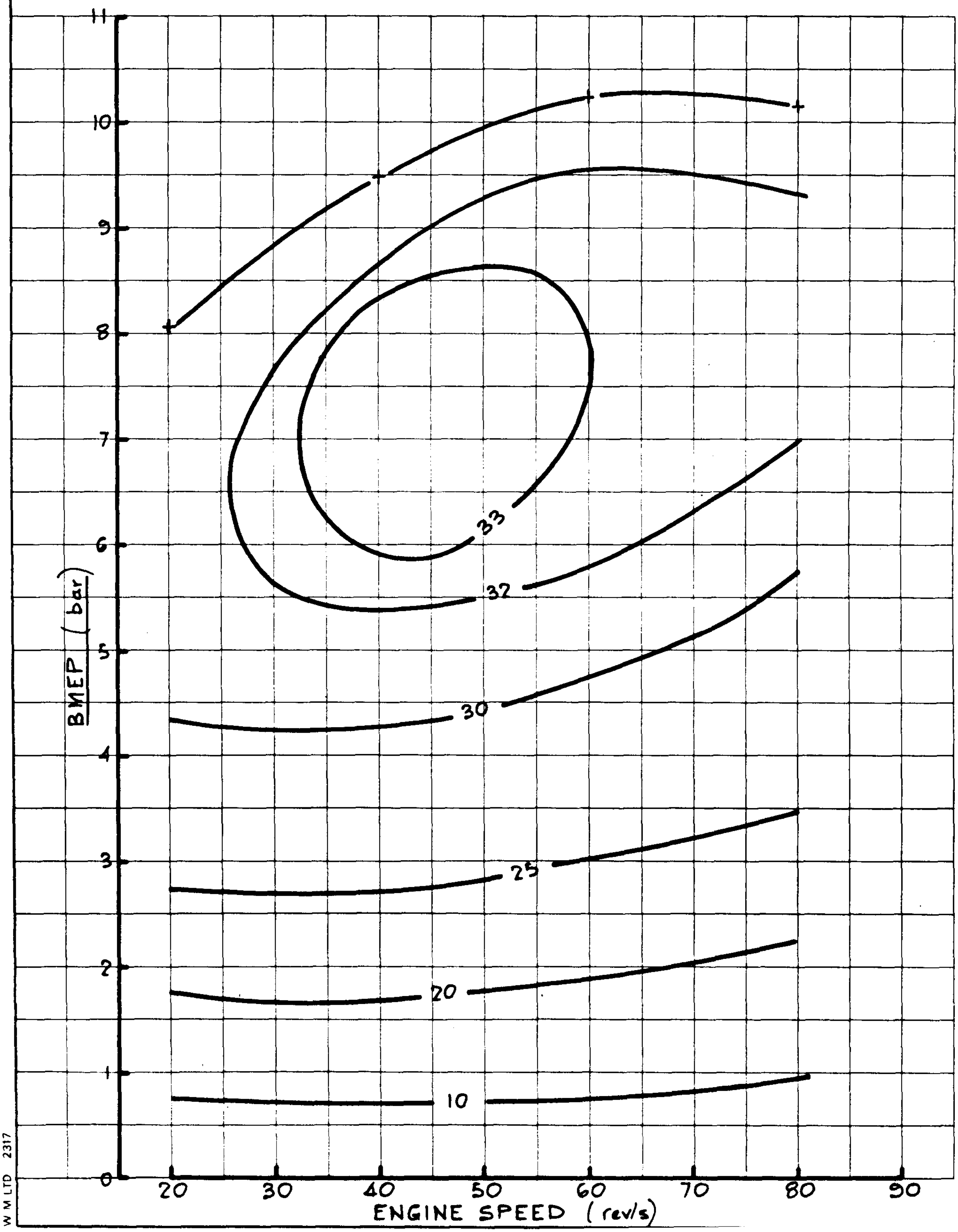
Date FEB. '86

VW. HRCC METHANOL 1·457l (79·5mm x 73·4mm)

ENGINE MAPPING, BRAKE THERMAL EFFICIENCY CONTOURS

M.E.C. AUTO FUELLING / AUTO IGNITION - NO EGR

BEST ECONOMY - MBT IGNITION TIMING STRATEGY



W M LTD 2317

RICARDO

FIG. No. 118

Drg. No. D.56228

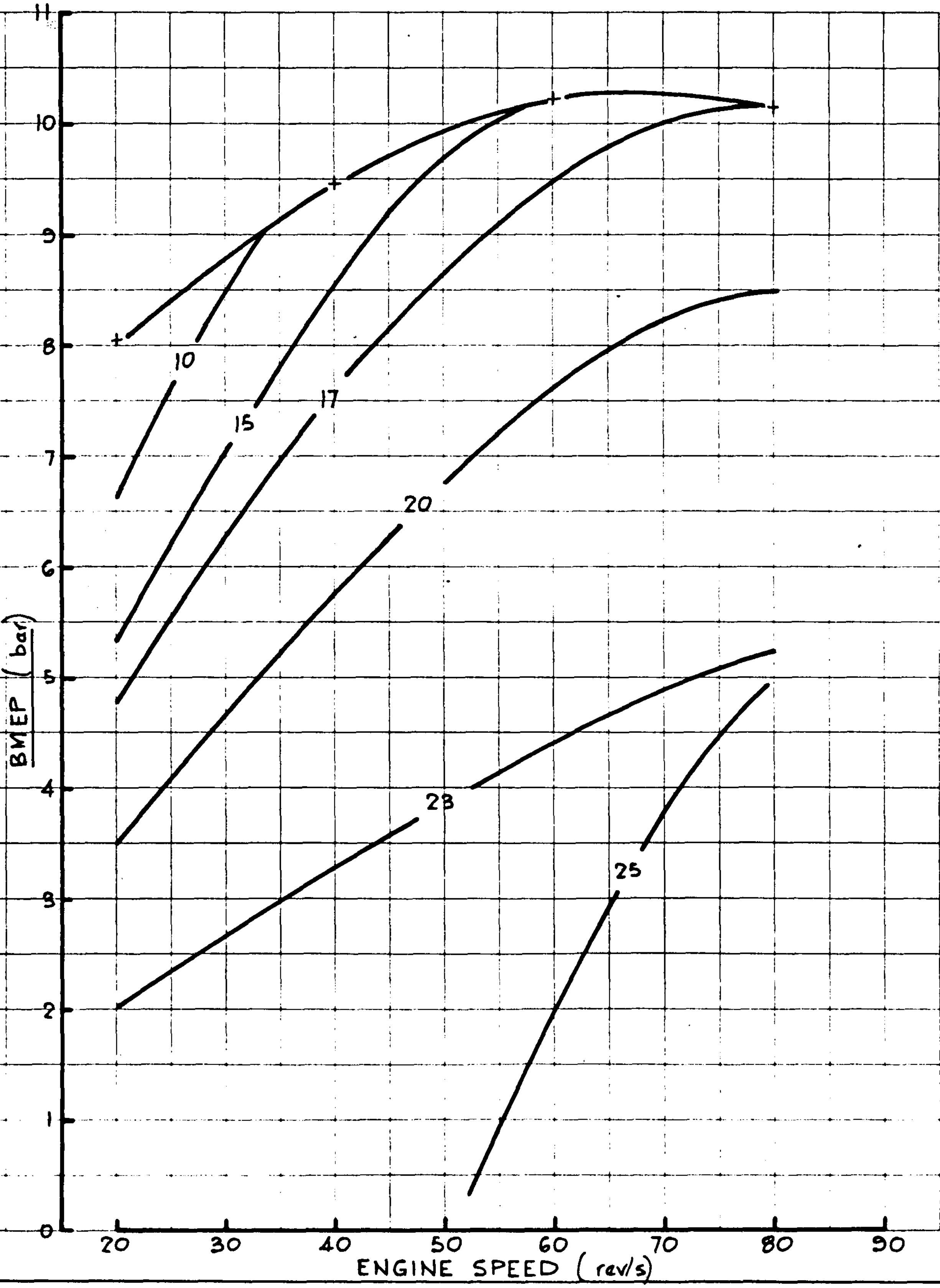
Date FEB.'86

VW HRCC METHANOL 1·457l (79·5mm x 73·4mm)

ENGINE MAPPING - IGNITION TIMING CONTOURS (°E)

M.E.C. AUTO FUELLING / AUTO IGNITION - NO EGR

BEST ECONOMY - MBT IGNITION TIMING STRATEGY



RICARDO

FIG. No. 119

Drg. No. D. 56230

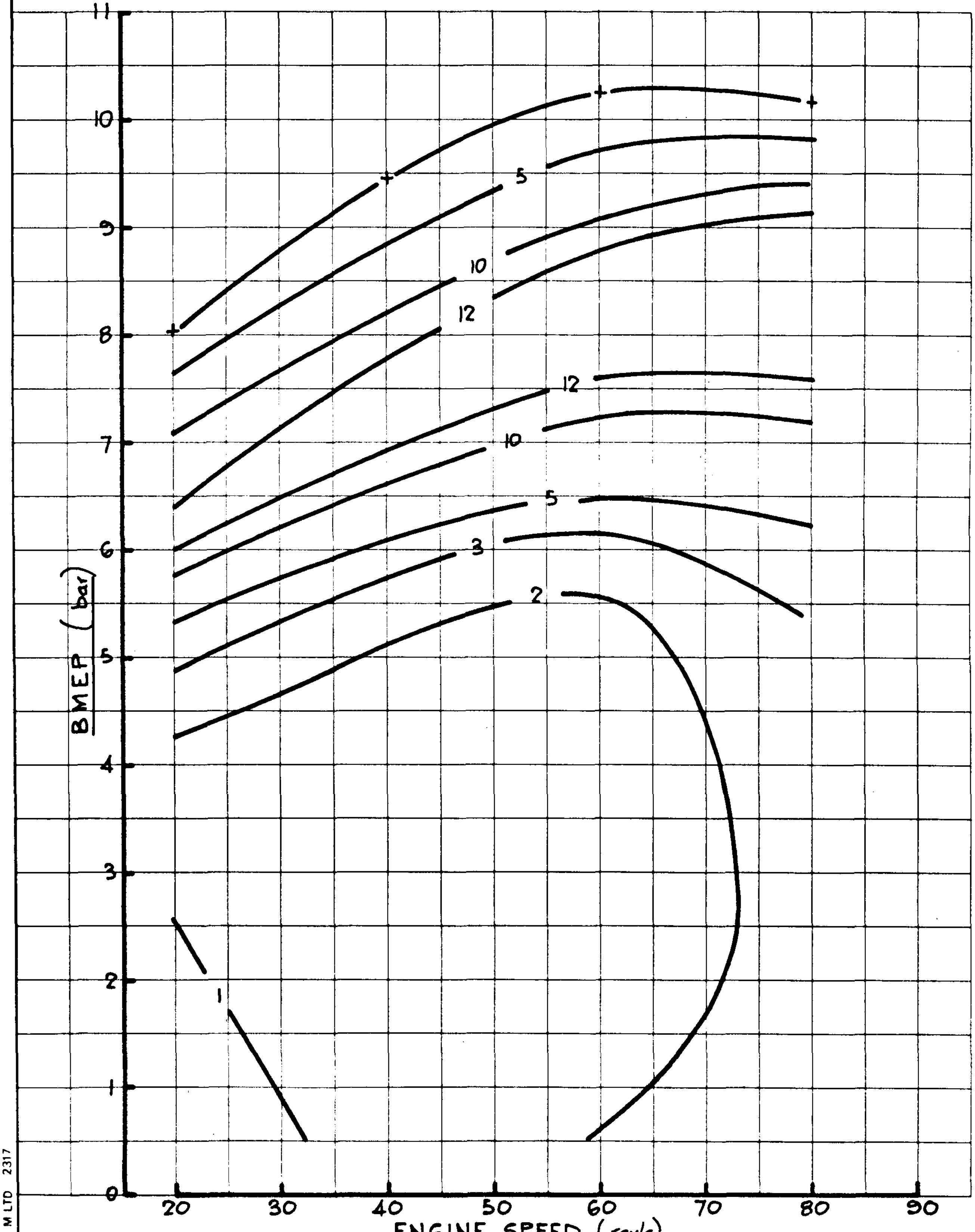
Date FEB.'86

VW. HRCC METHANOL 1.457 l (79.5 mm x 73.4 mm)

ENGINE MAPPING - B.S. NO_x CONTOURS (g/kW.h)

M.E.C. AUTO FUELLING/AUTO IGNITION - NO EGR

BEST ECONOMY - MBT IGNITION TIMING STRATEGY



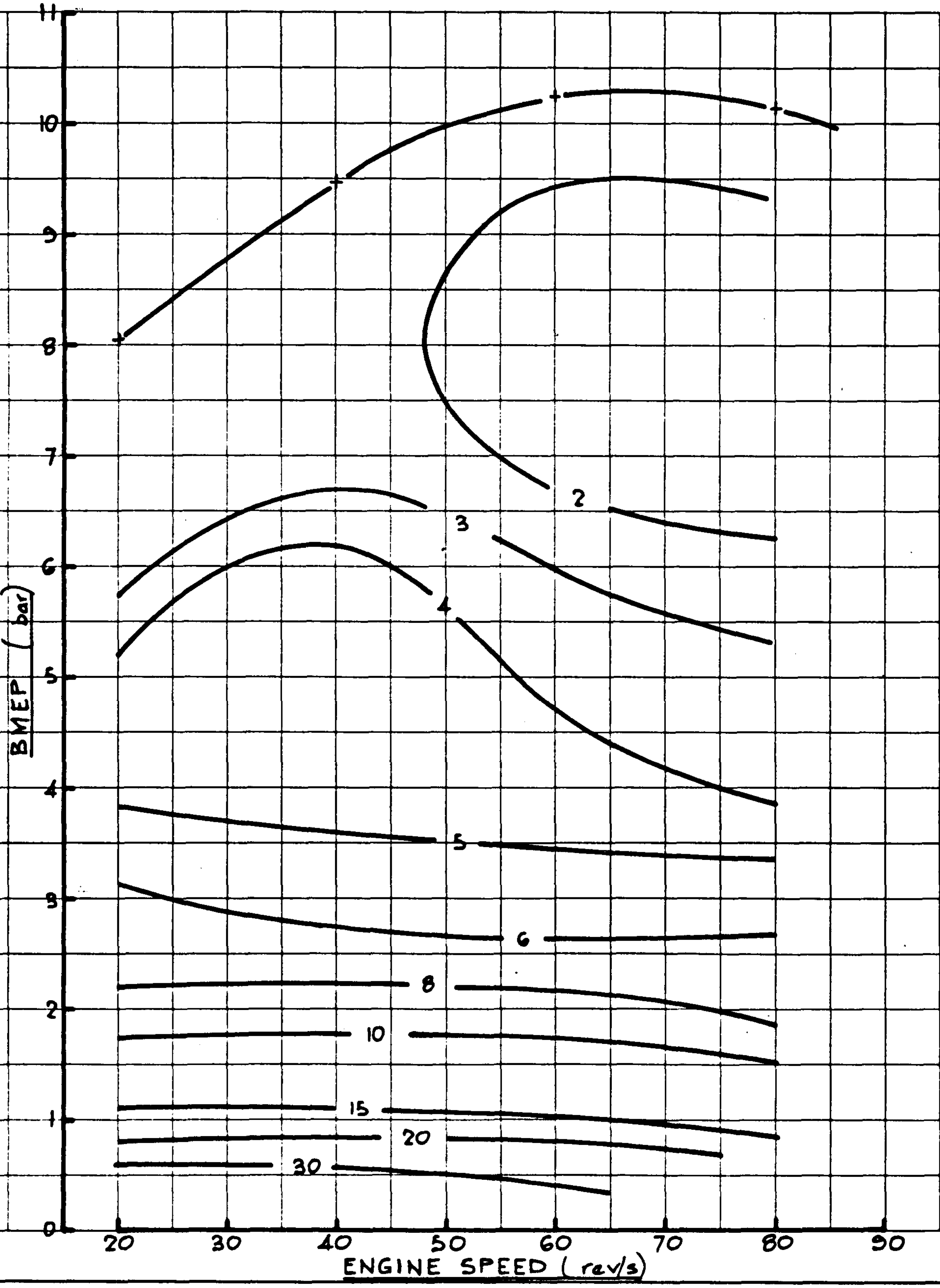
W M LTD 2317

RICARDO

FIG. No. 120
Drg. No. D. 56229
Date FEB. '86

VW HRCC METHANOL 1·457 l (79·5 mm x 73·4 mm)
ENGINE MAPPING - B.S.HC. CONTOURS (g/kW.h)
M.E.C. AUTO FUELLING / AUTO IGNITION - NO EGR

BEST ECONOMY - MBT IGNITION TIMING STRATEGY



G.L./L.M.

RICARDO

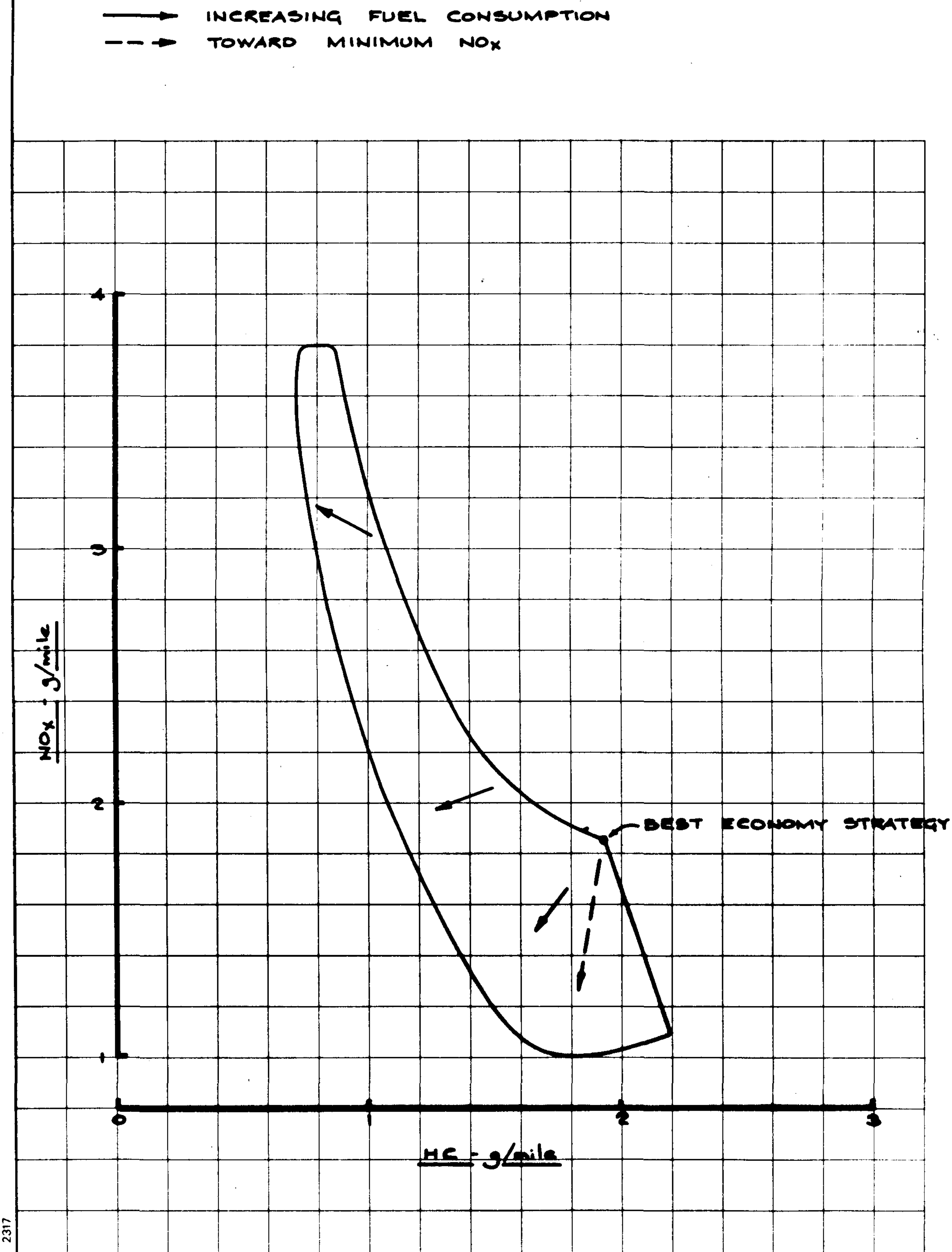
FIG. No. 121

Drg. No. DSG3G3

Date MARCH '86

VW HREC METHANOL 1·457ℓ [79·5mm x 73·4mm]

HC - NO_x TRADE OFF



W M LTD 2317

RICARDO

FIG. No. 122

Drg. No. D. 56231

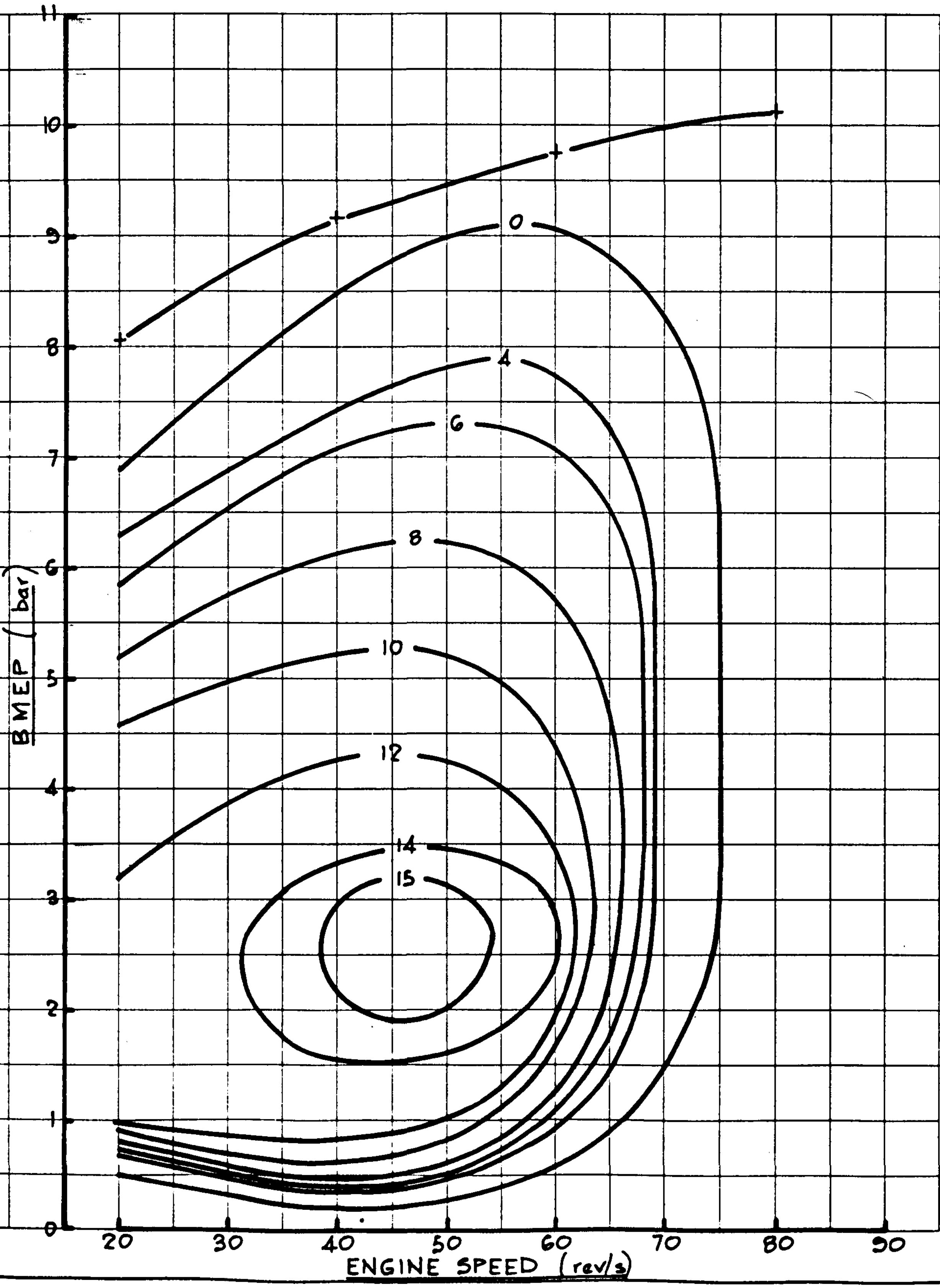
Date JUNE '86

VW HRCC METHANOL 1·457l (79·5 mm x 73·4 mm)

ENGINE MAPPING - EGR CONTOURS (%)

M.E.C. AUTO FUELLING / AUTO IGNITION / AUTO EGR

REDUCED NOx STRATEGY



W M LTD 2317

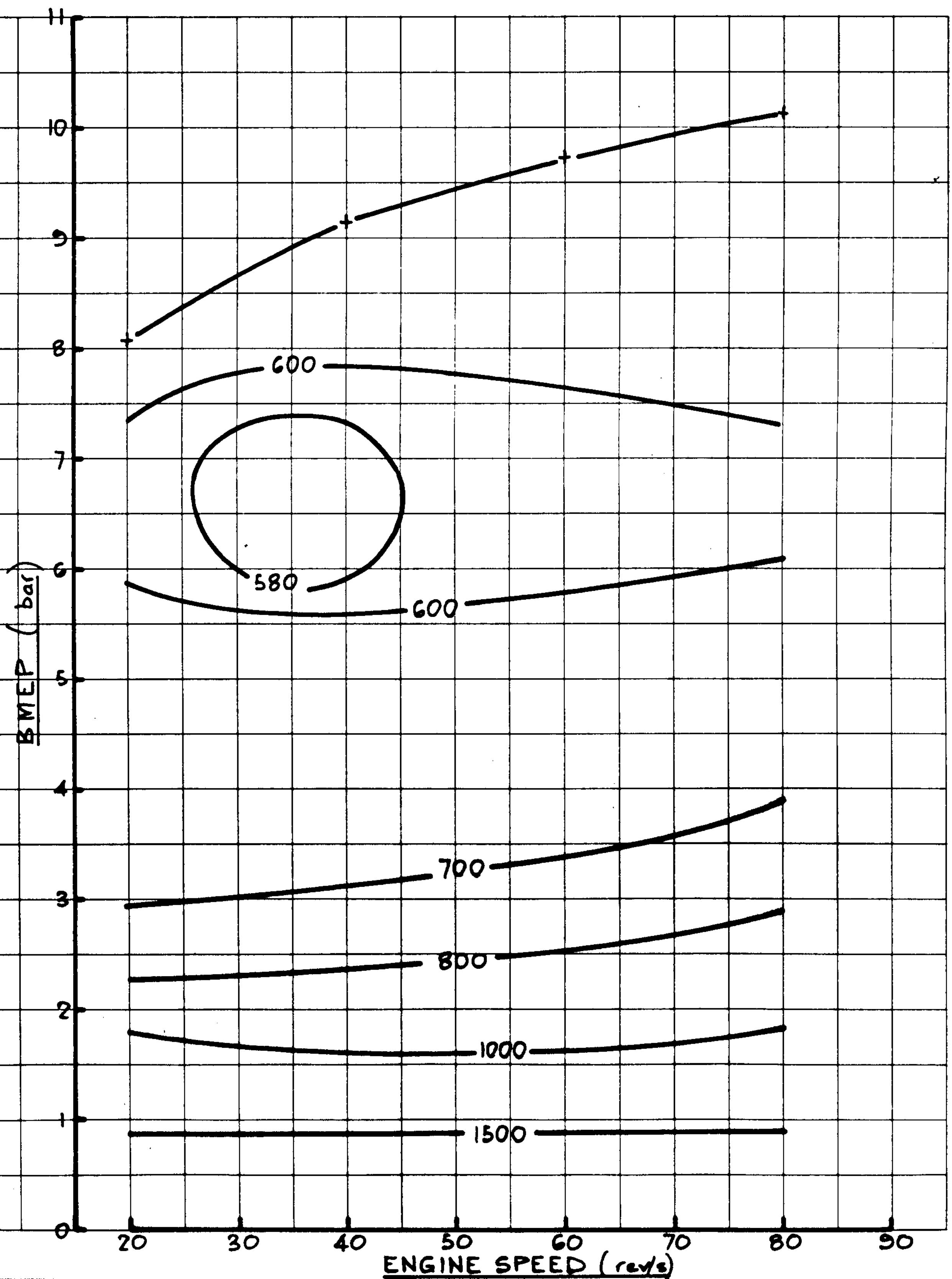
GL/BF

RICARDO

FIG. No. 123
Drg. No. D56397
Date JUNE '86

VW HRCC METHANOL 1·457 l (79·5 mm x 73·4 mm)
ENGINE MAPPING - BSFC CONTOURS (g/kW.h)
M.E.C. AUTO FUELLING / AUTO IGNITION / AUTO EGR

REDUCED NO_x STRATEGY



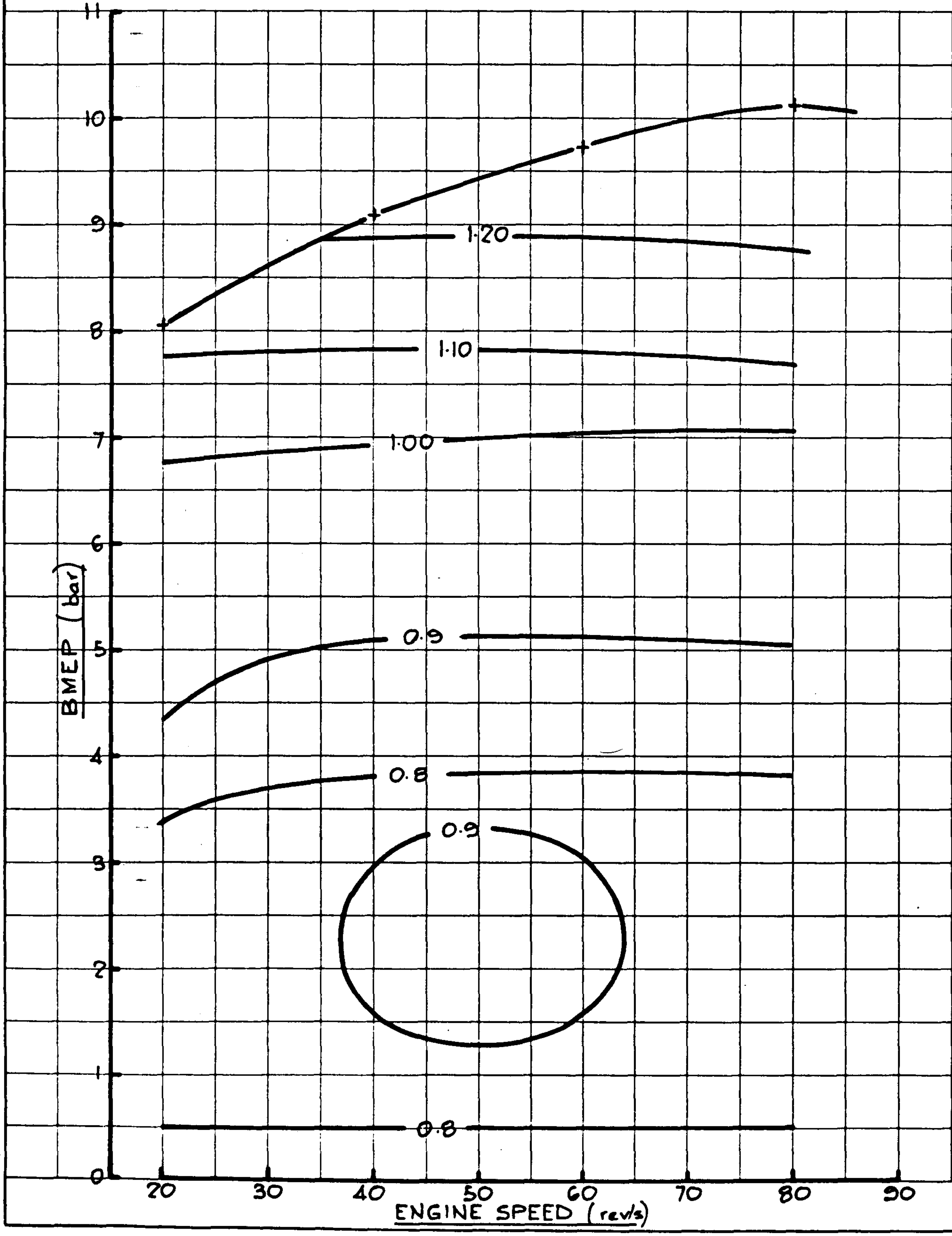
W M LTD 2317

RICARDO

FIG. No. 124
Drg. No. D56248
Date JUNE '86

VW HRCC METHANOL 1.457 l (79.5 mm x 73.4 mm)
ENGINE MAPPING - EQUIVALENCE RATIO CONTOURS
M.E.C. AUTO FUELLING / AUTO IGNITION / AUTO EGR

REDUCED NO_x STRATEGY



W M LTD 2317

RICARDO

FIG. No. 125

Drg. No. D56398

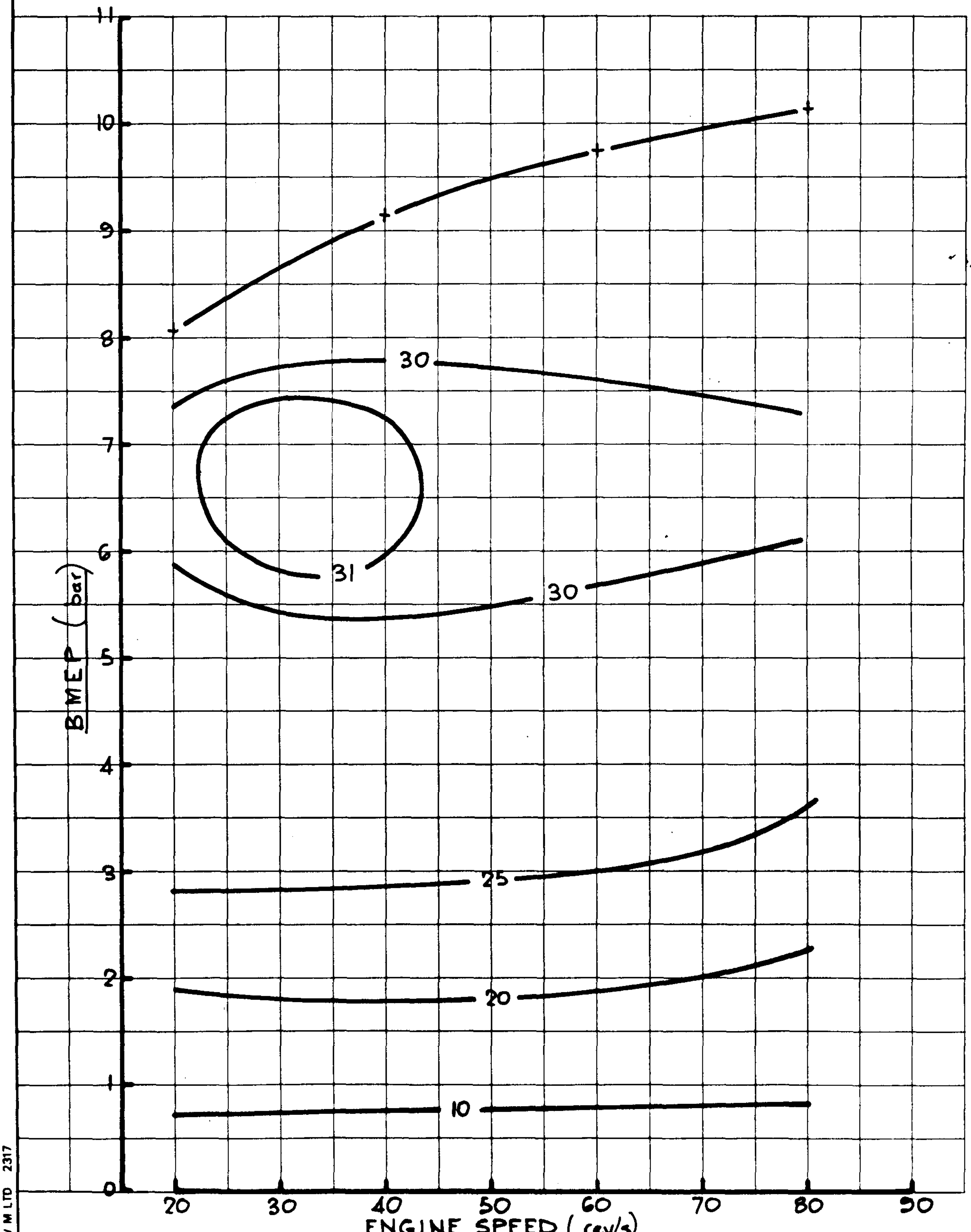
Date JUNE '86

VW HRCC METHANOL 1·457ℓ (79·5mm x 73·4mm)

ENGINE MAPPING - BRAKE THERMAL EFFICIENCY CONTOURS (%)

M.E.C. AUTO FUELLING / AUTO IGNITION / AUTO EGR

REDUCED NO_x STRATEGY



W M LTD 2317

GL/BF

RICARDO

VW HRCC METHANOL 1·457ℓ (79·5mm x 73·4mm)

ENGINE MAPPING - IGNITION TIMING CONTOURS (°E)

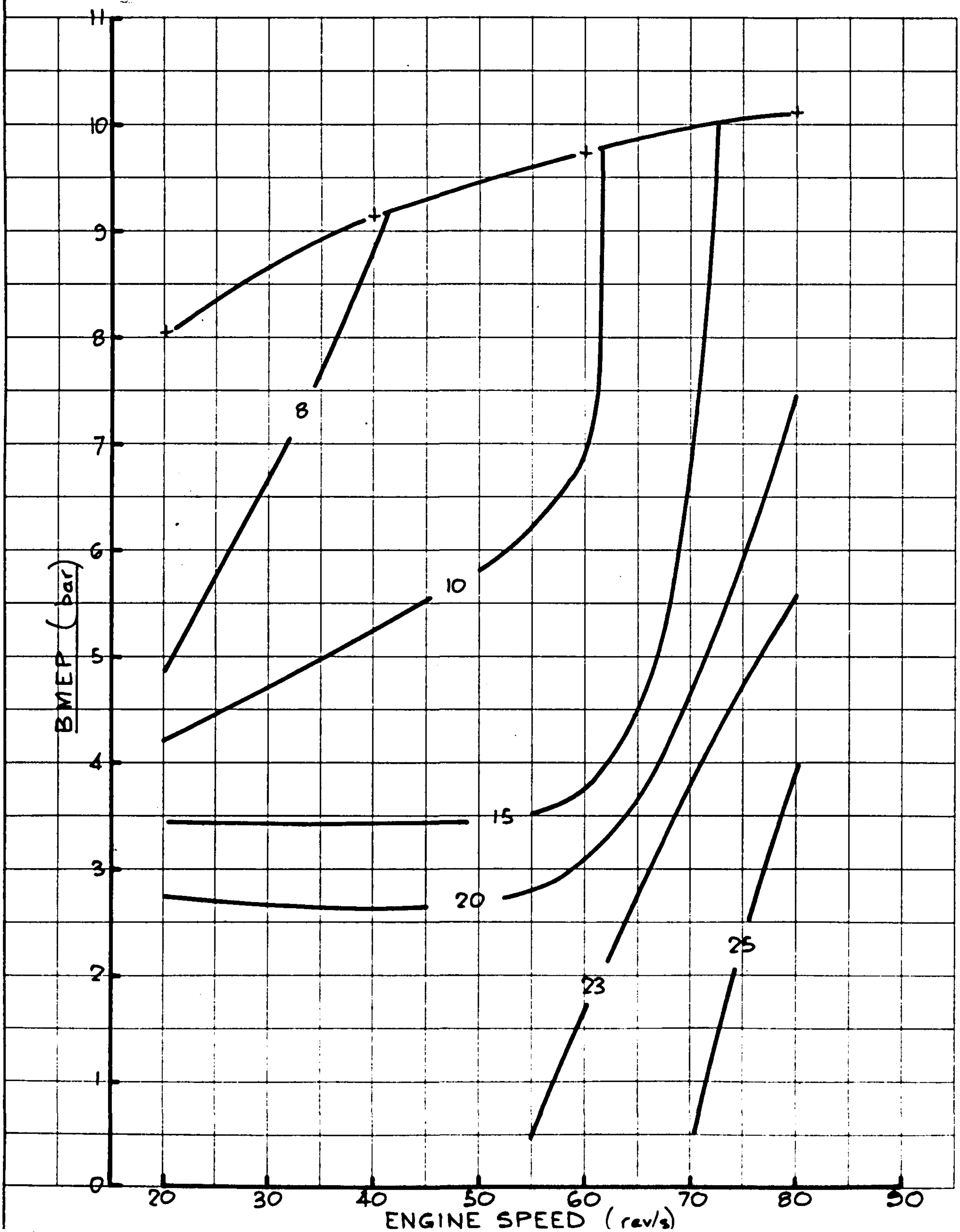
M.E.C. AUTO FUELLING / AUTO IGNITION / AUTO EGR

FIG. No. 126

Drg. No. D56399

Date JUNE '86

REDUCED NOx STRATEGY



N M LTD 2317

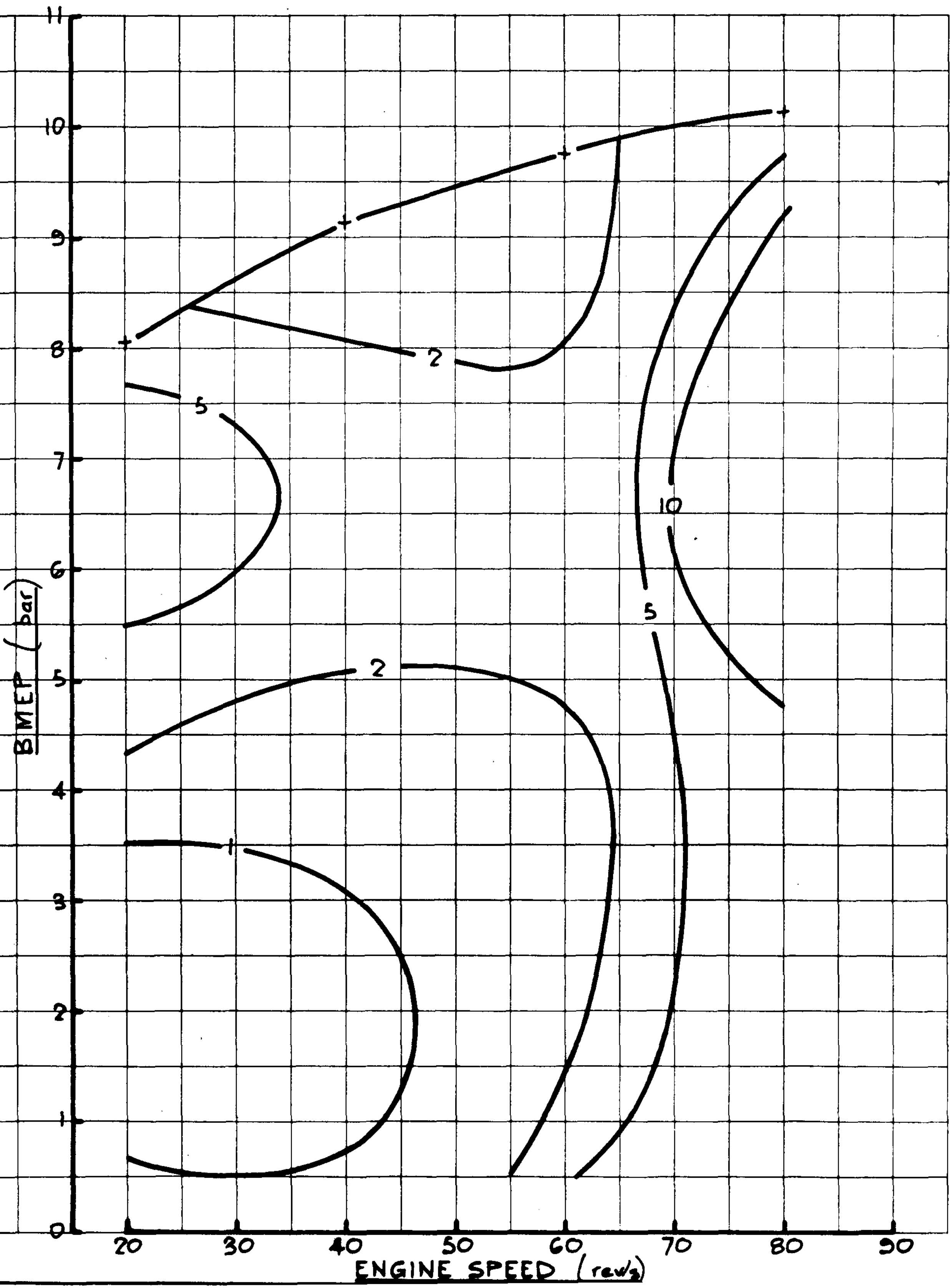
GL / BF

RICARDO

FIG. No. 127
Drg. No. DS6400
Date JUNE '86

VW HRCC METHANOL 1·457 l (79·5 mm x 73·4 mm)
ENGINE MAPPING - BS NO_x CONTOURS (g/kW·h)
M.E.C. AUTO FUELLING/ AUTO IGNITION/ AUTO EGR.

REDUCED NO_x STRATEGY



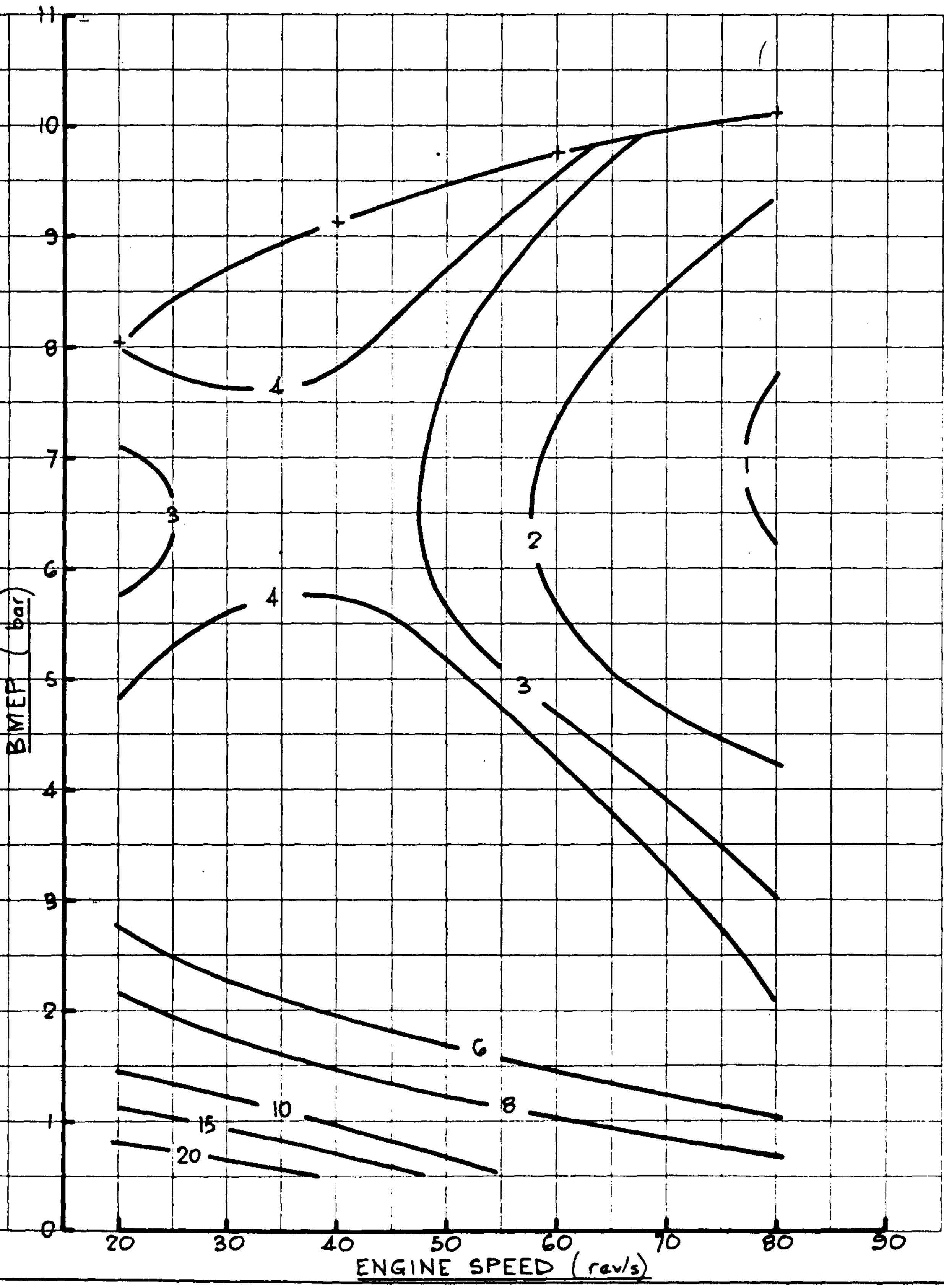
W M LTD 2317

RICARDO

FIG. No. 128
Drg. No. DS6401
Date JUNE '86

VW HRCC METHANOL 1·457 l (79·5 mm x 73·4 mm)
ENGINE MAPPING - B.S.HC CONTOURS (g/kW.h)
M.E.C. AUTO FUELLING/AUTO IGNITION/AUTO EGR

REDUCED NOx STRATEGY



W M LTD 2317

G.L./L.M.

RICARDO

FIG. No. 129

Drg. No. D 56362

Date APRIL '86

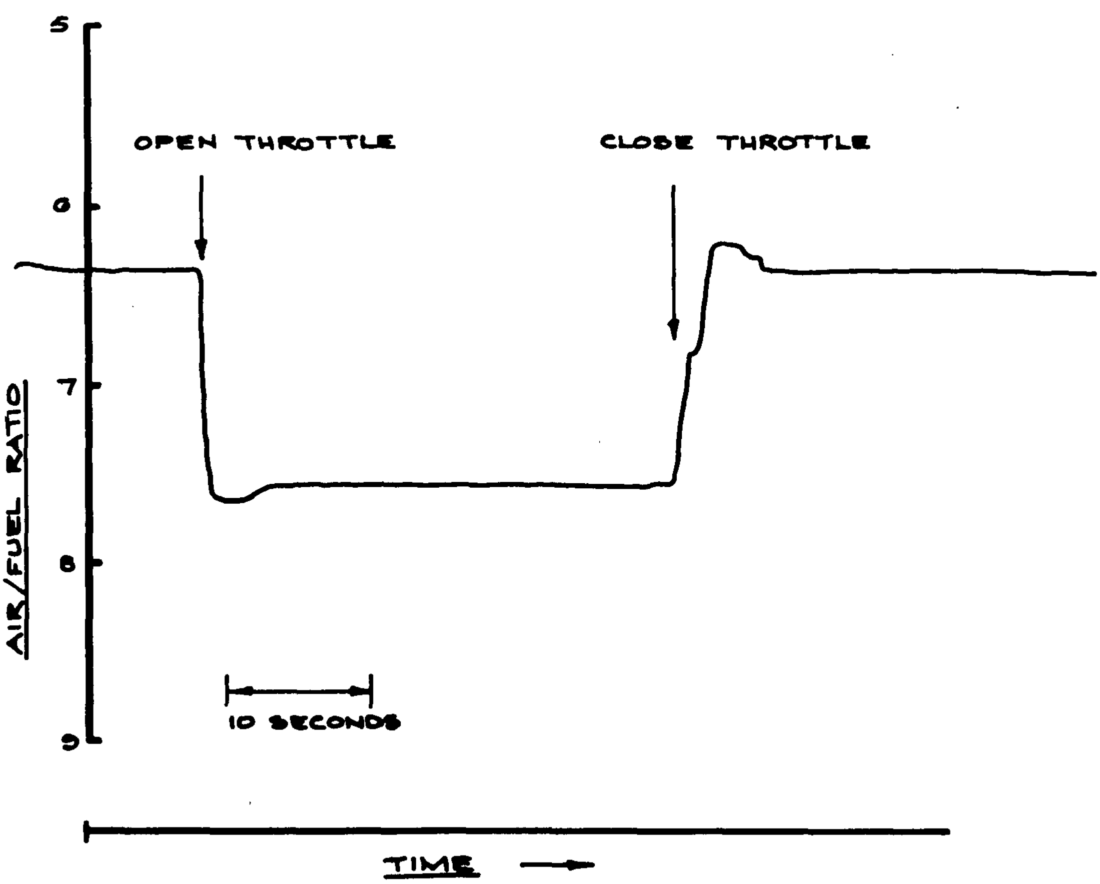
VW. HRCC METHANOL 1·457 l [79·5 mm x 73·4 mm]

EXAMPLE OF TRANSIENT TEST

E.G.R. STRATEGY

SPEED - 40 REV/SEC.

350-550 mbar ABSOLUTE



G.L./L.M.

RICARDO

FIG. No. 130

Drg. No. DSG3G1

Date APRIL '86

VW HRCC METHANOL 1·457l [79·5mm x 73·4mm]

EXAMPLE OF COLD START TEST

AMBIENT TEMPERATURE = 10°C