OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

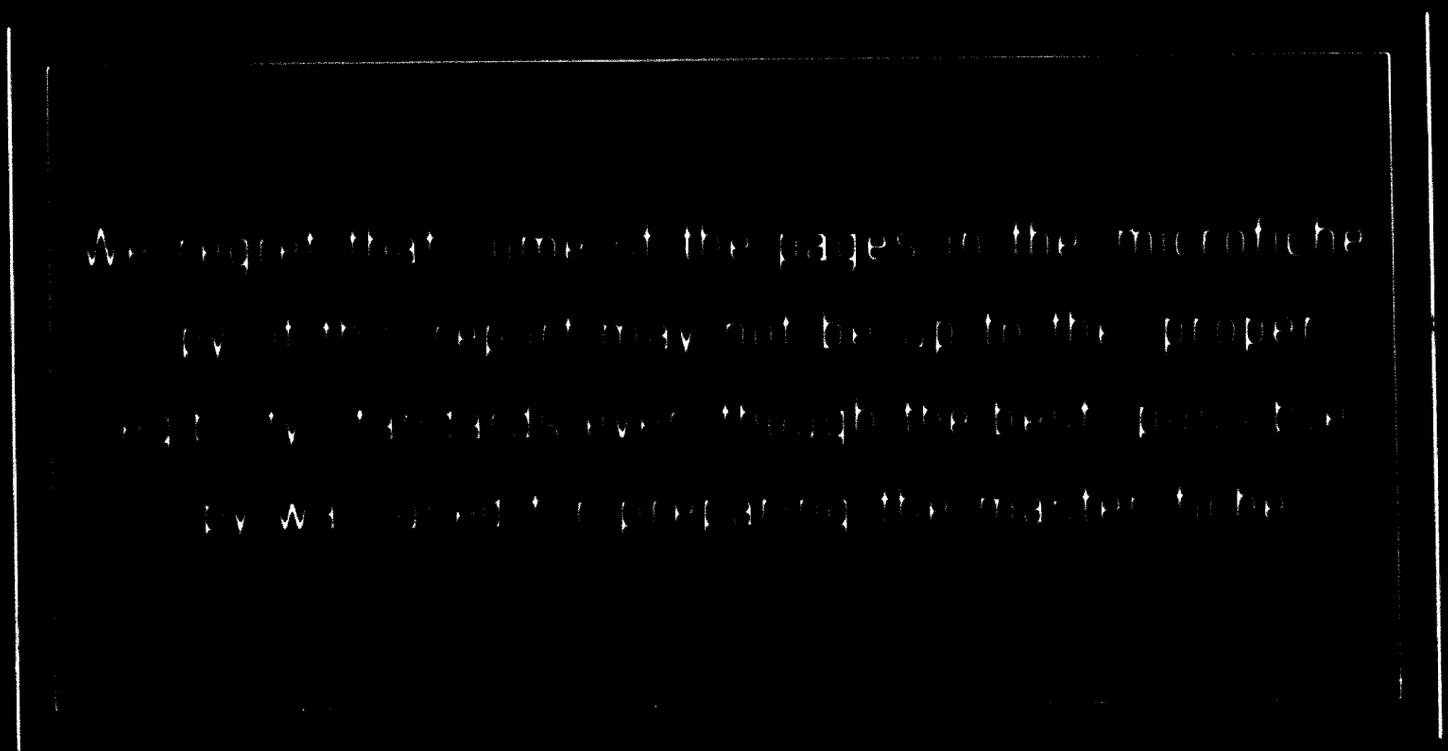
FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org



07925

DP/ID/SER.B/114
20 December 1977

RESTRICTED

English

LABORATORY FOR TESTING COMMERCIAL VEHICLES AND THEIR COMPONENTS[1/]

SI/ROM/74/809

ROMANIA

Terminal report

Prepared for the Government of Romania by the
United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of Guy H. Tidbury,
automotive engineer

United Nations Industrial Development Organization
Vienna

1/ This report has been reproduced without formal editing.

id. 77-8839

Explanatory notes

References to dollars ($) are to United States dollars, unless otherwise stated.

The following abbreviations are used in this report:

ICPAT	Institutul de cercetare si proiectare pentru autovehicule si tractoare (Research and Design Institute for Vehicles and Tractors)
kN	kilonewton

The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Mention of firm names and commercial products does not imply the endorsement of the United Nations Industrial Development Organization (UNIDO).

ABSTRACT

The purpose of the project entitled "Laboratory for testing commercial vehicles and their components" (SI/ROM/74/809) was to find ways and means to shorten the duration of tests and to improve testing techniques for vehicles and their components in order to obtain fast and reliable results on their performance. An expert, a mechanical engineer with experience in the testing of automotive vehicles, was sent to Romania for six months and was attached to the Research and Design Institute for Vehicles and Tractors (ICPAT) at Braşov.

This final report concentrates on the choice of the equipment required to enable ICPAT to perform as a modern design and development organization for a wide range of vehicles.

The main recommendations can be summarized as follows:

1. The provision of new data collection and processing equipment at a total cost of approximately $100,000 and the placing of a fellowship to ensure its optimum use.

2. The provision of an electronically controlled servo-hydraulic test facility at an approximate cost of $350,000.

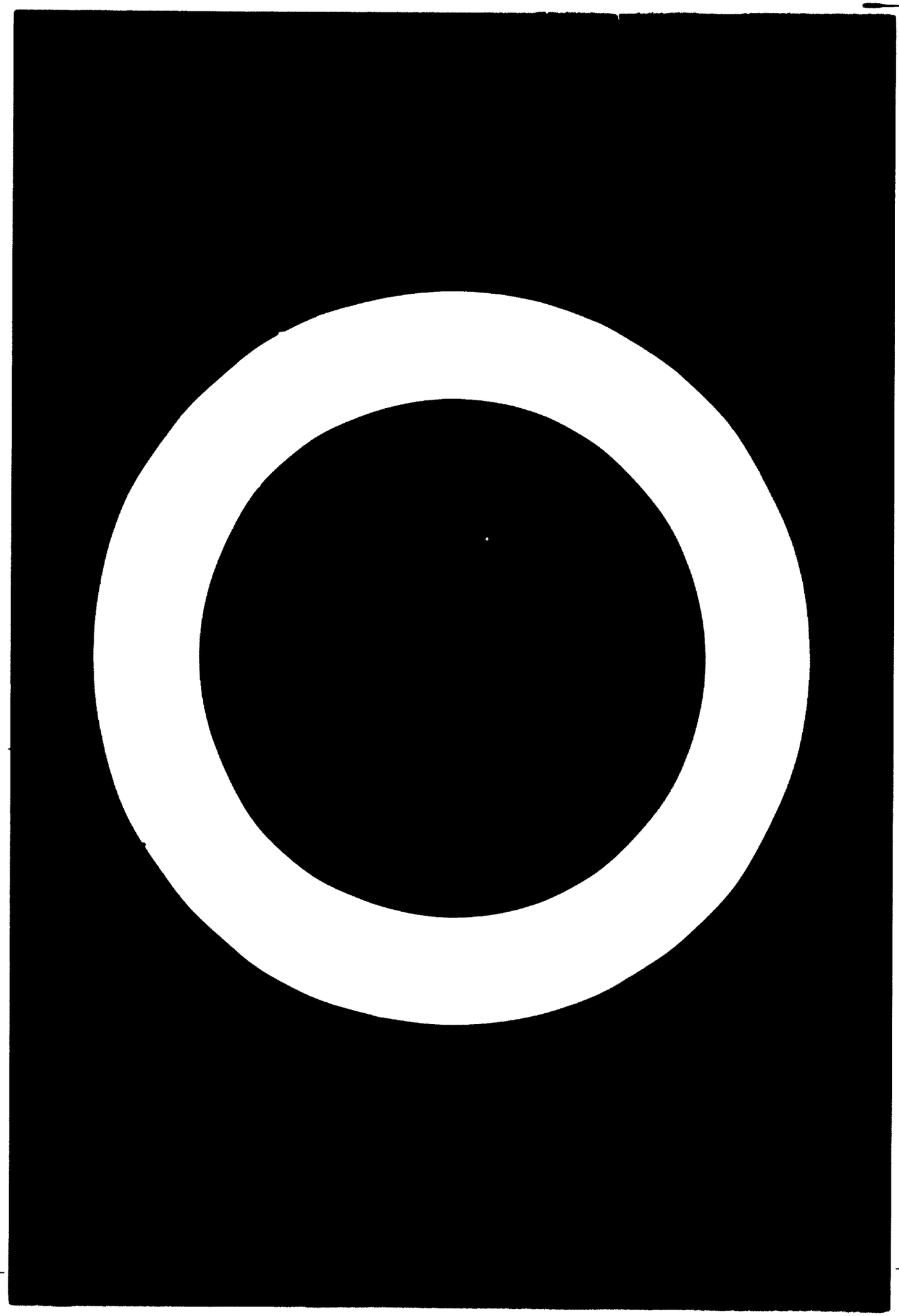
3. The institution of a more intensive road test programme.

4. The reinforcement of the recently instituted reliability programme by a short term visit by a special expert.

5. The priorities to be observed when building a test track and the offer of a fellowship to the engineer in charge to visit existing tracks.

6. That a greater effort be made in computer programming and the offer of a fellowship in this field.

7. That a United Nations project be initiated to enable the School of Automotive Studies to continue to assist ICPAT and other Romanian institutions for a period of three to five years.



CONTENTS

I. INTRODUCTION

The interim report made clear the expert's view that the engineering staff at I.C.P.A.T. are capable of using the most modern test equipment available and that I.C.P.A.T. is grossly under-equipped in this respect. The majority of that report stands and the main task of this final report is to make firm recommendations on the data collection and analysis systems most suitable for I.C.P.A.T. and to give further details of the servo-controlled hydraulic test system proposed. A brief explanation for the choices is given under the heading of Laboratory Vehicle Testing.

The mid-term visit to the United Kingdom was invaluable in this respect as well as being a succesful information gathering exercise for the design and development projects presented by I.C.P.A.T. for solution. (A summary of the activities during the visit is attached as Appendix 5). Summaries of the advice given by the expert on two of the problems dealt with are given as appendices 2 and3, but further information on all 9 problems listed in section 5 of the interim report was passed on to the relevant staff at I.C.P.A.T.

II. LABORATORY VEHICLE TESTING

All vehicle testing can be devided into:

a) Safety Testing.

b) Fatigue Testing.

c) Noise and Vibration Testing.

Safety testing is a well developed technique for tractor cabs and I.C.P.A.T have the necessary equipment. This equipment is suitable for the commercial vehicle cab tests proposed in E.C.E. Regulations 29. The roof loading test for buses in E.C.E. Regulation 36 is a simple test and would present no problem to I.C.P.A.T.

Fatigue or service life testing is the most difficult in that involves data collection and analysis as well as elaborate test equipment. Since the data collection and analysis systems have practically the same requirements as those used for noise and vibration testing they can be dealt with first.

The use of magnetic tape recording for collecting data from accelerometers, strain gauges or other transducers is practically universal. It was hoped that this might be replaced by a digital recording system but no recommended system is available except for low frequency 'event' recording and for this purpose a suitable system is suggested in the recommendations. A minimum recording system is set out in the recommendations to enable I.C.P.A.T. to determine the vibration mode shapes of vehicles while moving and also to make noise recordings away from base. After some experience with the recommended recorders it is probable that there will be a need for a 4 channel recorder to supplement the other equipment and literature on a suitable recorder has been left at I.C.P.A.T.

Data analysis has made considerable advances over the last few years and very sophisticated automatic 'on-line' equipments are now available. However the particular requirements of I.C.P.A.T. for understanding of the equipment and the flexibility to change the analysis in response to their own needs has led to the recommendation of a system developed by the Environmental Sciences Research Unit (E.S.R.U.) of the Cranfield Institute of Technology operating commercially as Cranfield Data Systems. This system is based on a standard minicomputer (INTERDATA) with standard peripherals and represents over 10 man years of software development. Since the system is so flexible it would be unwise to order from a 'catalogue' and the engineer in charge has offered to visit I.C.P.A.T.

and explain the system. If no order is contemplated he would expect it to be regarded as an expenses paid trip and this could well be the subject of a minor U.N.I.D.O. project. In any case the Unit would welcome a U.N. sponsored fellow to work with them in order to gain some experience in data analysis for various projects. Control Data Systems aspect to write a consultancy agreement into each contract to supply equipment in order to assist the customer to write special programs to suit his own particular analysis problems. This would ensure continued assistance to I.C.P.A.T. for several years. The complete system as recommended will provide a control system for fatigue testing as well as performing all the noise and vibration analyses that are likely to be required.

As the size of vehicles being tested by I.C.P.A.T. increases (100 ton dump trucks have already been designed) the cost of the actual fatigue testing equipment increases rapidly. As in the case of data analysis it would be unwise to order this type of equipment from catalogues. The recommended suppliers, Servo-Test Ltd., have indicated their willingness to discuss the problems with I.C.P.A.T. on site and then give quotations for either a) complete test rigs, b) a power supply and ring main system and/or c) suitable hydraulic actuators and control systems only. I.C.P.A.T. have some experience in the designing and building of test rigs using simple push-pull hydraulic actuators and could be expected to carry out the first part of the exercise. It would certainly be more satisfactory if Servo-Test Ltd. were to be asked to supply both the power supply and ring main system as well as the actuators and controllers and if finance is to be available should certainly be asked to do so.

Having obtained more detailed information on the cost of individual actuators etc. it appears that the estimate made in the interim report for such a system was correct and it is repeated in the present report.

For the noise and vibration testing of vehicles and components most organisations are equipped with several electro-magnetic vibrators. Recent experience has demonstrated that satisfactory results can be obtained with quite small vibrators of this type. A suitable vibrator and drive amplifier is specified in the recommendations.

III. RECOMMENDATIONS

The recommendations of the interim report are repeated and enlarged.

I. I.C.P.A.T. should make a comparative study of the volume and value of the vehicles produced by other organisations and the cost of their development test installations. As the author has found access to this information is not easy but some more data - some based only on verbal statements (and consequently memory) is presented in Appendix I.

II a. The following data collection equipment should be purchased.

one STORE 14 TAPE RECORDER manufactured by:
RACAL THERMIONICS LTD. $ 18,500

one NAGRA Model IV - SJ TAPE RECORDER $ 5,000

one DIGITRONIX DIGITAL RECORDING SYSTEM
comprising:
608 DIGITAL DATA LOGGER
SIGNAL CONDITIONING UNIT
REPLAY UNIT AND SPARES $ 6,300

II b. That discussions should be opened with Cranfield Data Systems for the purchase of the full 'Engineering Signal Processing System' at a cost of approx. $ 70,000. Since this is a flexible system firm orders should not be placed without a visit to discuss the problems by engineers from Cranfield, also it is recommended that a Fellowship be provided for 3 months to familiarise I.C.P.A.T. with the use of the equipment in a contract situation (see Appendix. 4).

II c. That Servotest Ltd. be asked to visit I.C.P.A.T. and tender for the provision of a system incorporating the following actuators:

4 x 100 kN max. force
2 x 500 kN max. force

It is estimated that such a system would cost approximately $ 350,000.

That a LING 400 VIBRATOR and suitable power oscillator be obtained to give 200 N force at a cost of $ 3,500 approx. from LING DYNAMIC SYSTEMS LTD. An alternative supplier of similar vibrators is DERRITRON ELECTRONICS LTD.

III. The most immediate way to improve the quality of Romanian road vehicles is to institute an intensive road test duration system using the statistical methods developed by the reliability group to analyse the results. The existing road system is well suited to such an enterprise with the exception of 'motor way' running.

in contrast to the developed countries where special bad road surfaces have to be built in test tracks. (see appendix 2).

IV. Support at the highest level should be given to an enlarged reliability programme. Large operating unit equipped with Romanian vehicles exist and should make an effective system possible for road vehicles. For agricultural tractors where the units are smaller specialist advice has been offered by Mr. B. Hogan, Visiting Lecturer in Reliability to the School of Automotive Studies, Cranfield and one time in charge of the reliability programme at Massey Ferguson Ltd., Coventry. A short term project (2weeks) should be initiated for him to visit Romania. (see Appendix 4).

V. The proposed test track could best be built in stages with priority given to the type of test that cannot be covered by (III) and (IV) above. The first stage should consist of:

a) - a mathematically developed random bump track

b) - a high speed circuit

c) - special facilities which are common for tractor and crawler tests

Other facilities which are common to most test tracks could be added later, e.g.:

a) - water splash and straight road section for brake testing

b) - dust tunnel

c) - constant gradient hill climbs

d) - variable friction surfaces

e) - vehicle handling area

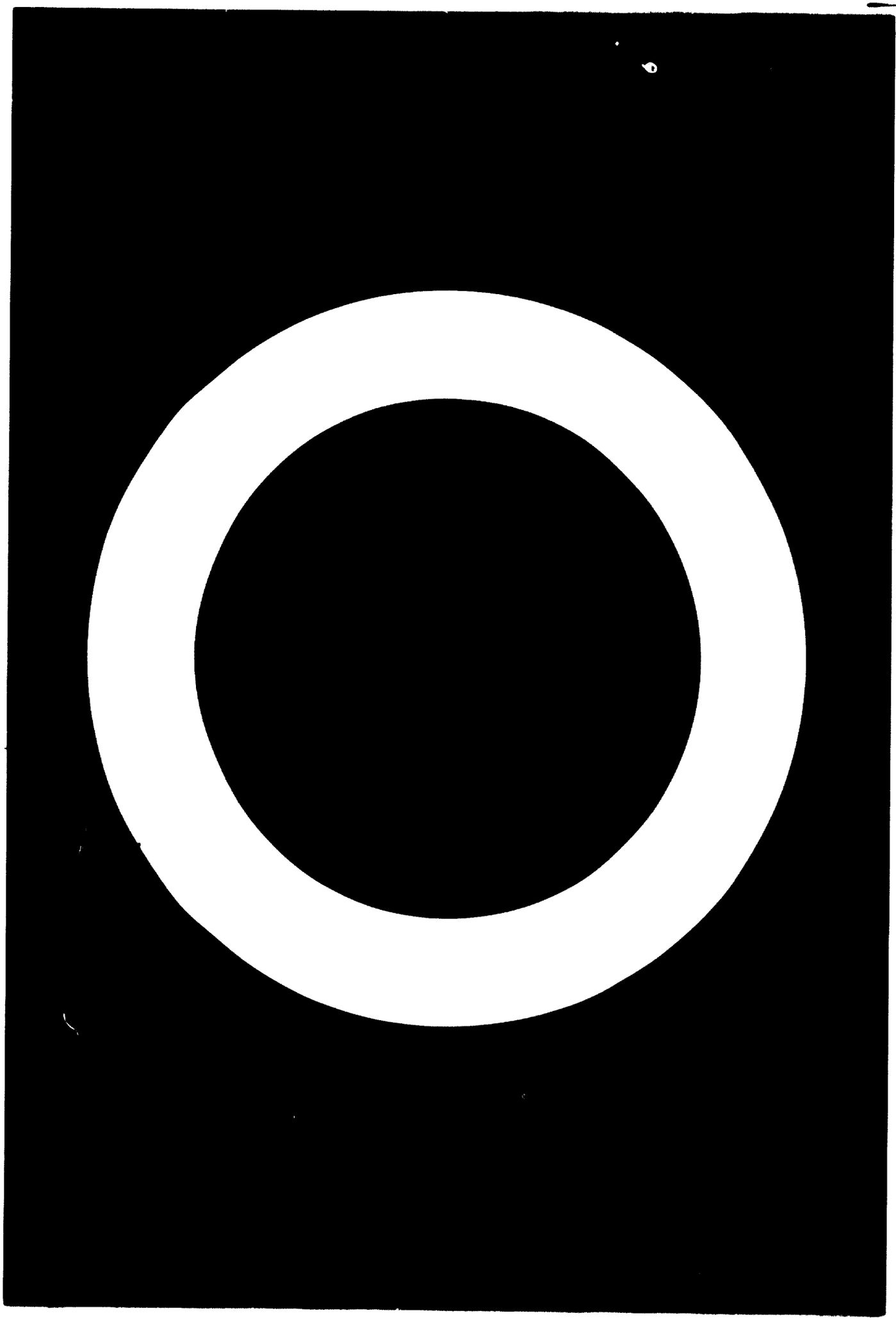
As a road system in the country improves it will be necessary to incorporate bad surface roads for duration testing.

Since a test track is currently being designed at I.C.P.A.T. on the basis of a paper study a Fellowship is recommended to visit existing test tracks.

Enquiries in the U.K. have confirmed that M.I.R.A. would be willing to accept such a fellow if normally funded by U.N.I.D.O. and MICHELIN Ltd. may be prepared to allow a visit to their test track near Clermont-Ferrand.

VI. The effort devoted to developing computer programs should be increased. There is an immediate need for a more comprehensive finite element program and for experience in the use of such programs. A fellowship should be set up for an engineer to spend 1 year with the S.A.S. Structural Design Group, Cranfield (see App. 4). On his return at least 2 additional engineers should be allocated full time to the development and use of finite element programs.

VII. There are several areas where the School of Automotive Studies could be of continuing assistance to I.C.P.A.T. and a project running for at least 3 years and preferably 5 years should be initiated to make this possible (see App. 4).



APPENDIX 1

COMPARISON OF VEHICLE OUTPUT AND TEST FACILITIES.

1. SAAB-SCANIA with a total annual production of 19,400 trucks in 1975 were installing electronically controlled servo-hydraulic test equipment more than 10 years ago.

2. AUTOKUT (Budapest) has recently installed a computer controlled servo-hydraulic test stand for a complete test at a reputed cost of 30 million Forints. The current annual output of IKARUS is 12,000 vehicles (AUTOKUT plays a similar role to IKARUS as does I.C.P.A.T. to the truck and tractor plants in Braşov).

3. FORD MOTOR Co. Ltd. (Great Britain) are installing a special purpose hydraulic test rig for commercial vehicle chassis frames at a cost of $ 300,000. This in addition to a large amount of general purpose hydraulic test equipment. Ford Commercial vehicle production is running at about 3,500 a week but it includes light vans.

4. British LEYLAND TRUCK and BUS Division are installing a hydraulic test facility at an estimated total cost of $ 870,000. The present production is about the same as Ford but the vehicle types are not defined and will include car based van vans.

5. VAUXHALL MOTORS Ltd. are installing a gear-box and axle test stand (with no servo-hydraulics) at a cost of $ 300,000. The production of the Bedford T.K. is currently similar to the total production of I.A. Braşov (Truck Plant).

6. The Polish authorities are having preliminary discussions with suppliers for the installation of a test rig suitable for testing a complete 8 wheeled vehicle, combine harversters and similar large units at an estimated cost of $ 1,300,000.

7. I.C.P.A.T. provides a test facility for I.A. Braşov (truck Plant), output approx. 35,000 vehicles per year, the Tractor Plant Braşov, output approx. 60,000 per year, 'Autobuzul'-Bucharest, output of buses, trolleybuses and vans not specified and several other plants manufacturing special vehicles, trailers etc. The test facility at I.C.P.A.T. is limited to the use of simple push-pull hydraulic jacks which do not allow the reproduction of service loading and which enforce very long testing times.

APPENDIX 2

DURABILITY TESTING

Road or site durability testing appears to be used in Romania for

a) Prototypes of complete vehicles

b) New designs of components of vehicles

These operations are essential but should be supplemented by the testing of sample production vehicles. In the interim report it was suggested that an enlarged reliability programme could replace such durability testing but further discussions with experts with more recent experience have presuaded me that a minimum durability test programme with production vehicles is essential. The main reasons are:

1. Very accurate statistics can be obtained for reliability engineers at a level of detail unobtainable with vehicles in operation.

2. Design and development engineers can inspect the vehicles on a regular basis and qualitatively assess the behaviour of the vehicles and components.

Some notes on the organisation of such an operation were given to I.C.P.A.T. together with observations made by the writer on a single abreviated duration run. These observations concentrated on minor components whose behaviour could be noted by a passenger but which are very important in the competitive position of vehicles in export markets.

APPENDIX 3

VEHICLE STRUCTURAL DESIGN

1. Much of the design of vehicle structures is now governed by regulations e.g. E.C.E. 29 for safety tests on truck cabs and E.C.E. 36 for roof loading of buses. Romania has agreed to conform to both of these regulations. Discussions are currently proceding on roll over safety regulations for buses and these have been reported in a paper given both at Brașov and Bucharest (see Appendix 6)
To ensure that new designs can meet this type of regulation without undue weight penalty large deflection finite analysis programs are necessary. Such a program is available at Cranfield and the recommended fellowship on finite element analysis should enable I.C.P.A.T. to use it.

2. Light weight is the most important factor in the design of those structures not governed by regulation. It has been suggested to I.C.P.A.T. that the value of weight saving be estimated where possible. This enables proper decisions to be taken on the time to be spent on analysis, the desirability of using lightweight materials and the effort to be put into testing prototype structures.
The Refrigerated Semi-Trailer project is a particularly good example where this type of economic analysis is possible. Such trailers are used by a small number of large organisations for the transport of meat carcasses. The transport organisation must be able to estimate the value of transporting additional carcasses over the expected life of the vehicle. Realistic cost maxima could then be placed on contracts for the redesign of the vehicles.

APPENDIX 4

FELLOWSHIPS AND ADDITIONAL PROJECTS.

1. That I.C.P.A.T. be granted a Felloship to study the use of finite element structural analysis methods in the design of vehicles with the Structural Design Group of the School of Automotive Studies, Cranfield Institute of Technology (see attached brochure). - DURATION - 1 YEAR -. My choice for this fellowship would be Ing. GROVU MIHAI. Ing. Grovu would require an intensive course in English and must satisfy the British Council representative in Bucharest of his ability in English before starting the fellowship. Alternatively the fellowship could be extended to include a course in English in the U.K. His proven ability to write computer programs and his enthusiasm for the finite element method make him the only suitable candidate.

2. That I.C.P.A.T. be granted a Fellowship to study the use of data processing systems with Cranfield Data Systems, The Environmental Science Unit Cranfield Institute of Technology. - DURATION - 3 MONTHS -.

My choice for this fellowship would be Ing. VASU OCTAVIAN. Ing. Vasu speaks English fluently and has sufficient theoretical knowledge of data processing systems to take up the fellowship as soon as possible.

3. That I.C.P.A.T. be granted a Felloship to visit test tracks and proving grounds. If possible these should include TOYO-KOGYO and MITSUBISHI . Japan, MIRA - U.K., MICHELIN - France, PIRELLI TRUCK TEST TRACK - Italy. - DURATION - 2 MONTHS -.

My choice for this fellowship would be Ing. TARAS GHEORGHE. Ing. Taras speaks fluent French and some German. He has previously travelled to the U.S. and other countries and it is usually possible to find engineers with sufficient language ability to make the information visits profitable.

The Fellowships are listed in order of importance, the first being by far the most useful for the development of I.C.P.A.T.

4. That a 2 week visit to Romania as a special short term expert be offered to Mr. B.Hogan, Visiting Lecturer, School of Automotive Studies, Cranfield, to discuss reliability problems with C.I.A.T.

5. That a 1 week visit to I.C.P.A.T. as a special short term expert be offsred to Mr. R.Wallace, Cranfield Data Systems to lecture on the problems of data analysis.

6. That a 3 year or, preferably a 5 year Project be set up for the School of Automotive Studies to provide continuing assistance to I.C.P.A.T. and other organisations in Romania e.g. Braşov and Bucharest Politechnic. The financial details of the project to be agreed but should include a consultancy fee and travel expenses for several visits a year each way.

APPENDIX 5

ACTIVITIES ON BEHALF OF U.N. DURING U.K. VISIT 6 - 27th JULY 1977

Visited:

a) The National Institute of Agricultural Engineering

b) The Environmental Research Unit, Cranfield Institute of Technology

Visited by representatives of:

- Hewlett Packard Ltd.
- Servo-Test Ltd.
- Digitronix Ltd.

Obtained brochures and approximate quotations from:

- Spectral Dynamics Corporation
- Racal Thermionics Ltd.
- Ling Dynamic Systems Ltd.
- Bruel and Kjaer
- Derritron Ltd.
- Novatech Ltd.

Obtained copies of papers, theses etc. on the following subjects:

- Truck cab aerodynamics
- Earth moving vehicle structures
- Finite element computer programs
- Articulated vehicle ride and handling
- Drive line vibration programs
- Truck frame stress analysis
- Dynamics of articulated steer vehicles
- Diesel engine combustion
- Vehicle noise sources and noise control etc., etc.

Discussions have been held with Cranfield staff on many of the above subjects and

- Reliability analysis
- International library and information systems
- Welding design for vehicles etc.

The School of Automotive Studies, Cranfield, made accomodation and librarian time available for this work.

APPENDIX 6

VISITS AND LECTURES.

During the course of the mission the expert has visited the following establishments:

1. I.A. Braşov
2. I. Tractoare Braşov
3. Braşov University
4. I. "Autobuzul" - Bucharest
5. Institutul Politehnic - Bucharest

In the case of I.A. Braşov (Truck Plant) some written advice was given on questions raised during the visit and further information was gathered on the U.K. visit on the same questions.

Verbal advice was given to "Autobuzul" on several questions.

The following lectures were given:

1. 'Thin Walled Beam Theory in Chassis Frame Design' given at I.C.P.A.T. to approximative 80 engineers from I.C.P.A.T. and Braşov University on 27.6.77.

2. 'The Investigation of P.S.V. (Bus) Roll Over Safety' a joint paper of which the expert was one of the authors first presented at the Conference on the Design, Construction and Operation of Public Service Vehicles jointly sponsored by the Automobile Division of the Institution of Mechanical Engineers and the School of Automotive Studies, Cranfield, given at the Polytechnical Institute - Bucharest to the staff of the Polytechnic and engineers from Autobuzul on 13.9.77.

3. 'Teaching and Research in Body Engineering at Cranfield' given at the Polytechnic Institute in Bucharest on 14.9.1977.

APPENDIX 7

STAFF OF I.C.P.A.T. CONSULTED

During the course of the project the expert worked with many engineers at I.C.P.A.T. in particular the following:

Dr.Ing. Nicolae Petrescu
Ing. Ion Stanciu
Ing. Mihai Grovu
Ing. Octavian Vasu
Ing. Nicolae Ropotică
Ing. Mihai Gheorghe
Ing. Maria Bogdan
Ing. Gheorghe Iancu
Ing. Costel Bejan
Ing. Gheorghe Taras
Ing. Florin Tomescu

APPENDIX 8

ADDRESSES OF RECOMMENDED SUPPLIERS

RACAL THERMIONIC LTD. - Hythe,
Southampton
Hampshire, SO4 6ZH
ENGLAND

Agents for Romania:

Rohde Schwarz Tektronix GmbH Co Kg,
Sonnieithnerstrasse 26,
A - 1100 WIEN,
AUSTRIA

DIGITRONIX LTD. - 10 BURWEKS LANE
Kiln Farm Industrial Estate
STONY STRATFORD
Milton Keynes
MK 11 3AA
ENGLAND

NAGRA TAPE RECORDER

Manufactured by Kudelski S.A. - SWITZERLAND

Address obtainable from British Agents: Hayden Laboratories Ltd.
17 Chesham Road
Amersham , Bucks
ENGLAND

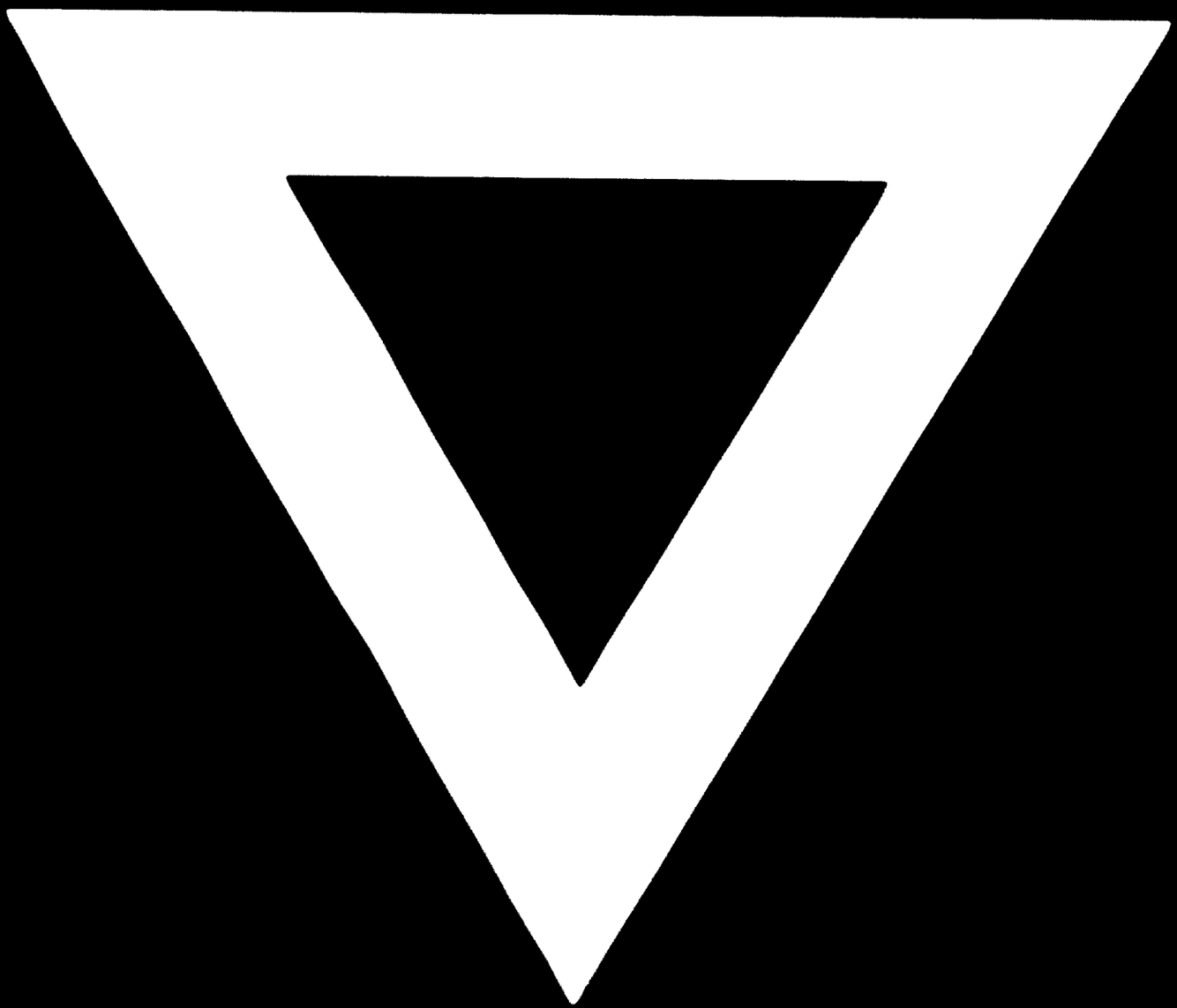
CRANFIELD DATA SYSTEMS
Wharley End
CRANFIELD - BEDFORD
MK 43 OAL
ENGLAND

SERVOTEST LTD. - Servotest Works
Sarsfield Road
Perivale - Greenford
Middlesex
UB6 7AA
ENGLAND

LING DYNAMIC SYSTEMS LTD. - Heath Works
Baldolk Road
Royston, Hertfordshire
SG8 5BQ
ENGLAND

DERRITRON ELECTRONICS LTD.
Sedlescombe Road North
Hastings - East Sussex
TN 34 3XB
ENGLAND

C-700



78.12.13