

Sir Ieuan Maddock, C.B., O.B.E., D.Sc., F.Inst.P., F.Eng., F.R.S., Chairman.



Dr. Victor Yarsley, O.B.E., unveiling a portrait of himself, 55 years after he founded the Yarsley organisation.

The front cover is a colour coded image generated by Fulmer's ultrasonic skin scanner. The skin surface, represented by delineation of the dermis and epidermis is on the right of the image; subcutaneous tissue and a blood vessel, of approximately circular section, are indicated by the broken colour regions and dark area to the centre and left of the image.

Chairman's Foreword

Fulmer is in the business of providing technological services to a wide range of industries as well as to Government and other organisations. These services cover the whole evolutionary process for a manufactured product or a manufacturing process from initial research through technology advancement, design and development, prototype manufacture, testing, quality control and assurance, and certification. The major industries we serve are electronics, aerospace and surface transport, health care, building services, chemicals, polymer processing, energy, consumer products, and defence. In this review we highlight some of the specific achievements for 1986, as well as providing a reminder of our continuing services to clients.

Major Achievements

Skin cancer is becoming an area of increasing concern to the medical profession as the proportion of deaths from this cause continues to rise, especially among relatively young people. The early diagnosis of melanomas is a laborious procedure involving the taking of biopsy sections and their examination by skilled pathologists. Using our high frequency ultrasound technology, coupled with advanced digital electronic processing, we can now produce a colour coded image of skin showing internal features below the epidermis, including the appearance of potentially cancerous penetrations. The equipment is being developed for the early diagnosis of melanomas and other skin cancer conditions, and for testing cosmetic and pharmaceutical preparations.

To exploit both areas we have formed a subsidiary company, Fulmer Dyson, which has now signed an agreement with an American marketing operation, MUST (Multifrequency Ultra Sound Technology), to develop, manufacture and sell skin care equipment for medical, cosmetic and pharmaceutical applications.

Other work in the health care industry has been the successful development for Vickers Medical and Boots Celltech of drug and reagent dispenser devices and the award of a DTI contract for advanced robotics development in health care.

Our abrasivity monitor, which was initially developed for monitoring the abrasiveness of magnetic computer tape, has now been developed for monitoring fluids. Three licensees have now been appointed; Fairey Arlon for hydraulic applications, Graviner for marine diesel applications, and Cormon for applications associated with corrosion monitoring. The concept has also been extended to flat surfaces such as floppy disks, paper cloth, and even to highly abrasive surfaces such as emery paper.

Both the skin scanner and the abrasivity monitor illustrate two main features of Fulmer's recent business activity. The first is our increasing activity in sensor development; the second is in the design for manufacture of advanced electronic equipment. In the sensor field we have continued to enlarge the range of devices using our polyvinylidene fluoride piezo and pyro electric film. This is now being used not only in broad band transducers for ultrasonics, but for other very delicate pressure sensing work, for liquid level measurement, and for heat detection. Applications in the food and healthcare industries are being examined.

Under contract from Cogent Limited, a silicon sensor for the detection of potentially dangerous concentration of hydrocarbon gases is well advanced, as are other projects involving the microfabrication of silicon devices. Coupled with all this sensor work has been the production of advanced electronic equipment able to make full use of the information produced by all the various sensors and to process it into the appropriate digital or analogue form as required. This equipment, as with the abrasivity monitor, is being designed for manufacture and this is a growing part of Fulmer's services to industry.

During the year the first series of design guides for use by engineers in the design of spacecraft was completed for the European Space Agency; the final stage of the development of improved corrosion-resistant stainless steels for use in deep mines was completed; three target modules were manufactured and supplied for the SERC spallation neutron source; many successful projects on diffusion bonding and hot isostatic pressing were completed; a handbook on abrasive wear control was compiled in conjunction with engineers from mainland China; and several training projects in developing countries were completed for the United Nations and for the Overseas Development Agency. The range of organo-fluorine compounds manufactured and sold for pharmaceutical intermediates and other purposes in the chemical industry was expanded; new facilities were installed for the production of boron nitride ware and the crucible size successfully extended to six inches diameter.

It has become a wearisome truism to say that Britain is good at research and invention but poor at innovation. In our contacts with City sources of finance for innovation we hear the continual complaint that projects cannot be supported because the sources of finance do not believe that the teams proposing the projects are capable of converting the ideas into industrially viable products or processes. Fulmer is increasingly capable of providing this expertise, as the above examples show. Once the products have been satisfactorily designed and manufactured Fulmer is able to arrange appropriate quality control, quality assurance and certification procedures.

During 1986 DTI contracts on quality assurance in the building and plastics industries were secured and a very significant start was made in establishing the Yarsley Quality Assured Firms Scheme as a certification body in these industries.

In all the activities undertaken during 1986, therefore, we continued to advance our total capability in taking projects all the way through from initial research to successful manufacture and sale, as well as extending our consultancy, failure evaluation, quality assurance and certification services to those manufacturers who require our help to improve and extend their own products and services.

The new building at Yarsley Technical Centre, Redhill, which has enabled unification of Yarsleys facilities on one site.



Fulmer Income Sources 1986:

	£K
UK Industry	3,036
UK Government	680
Europe	360
North America	239
Other	371
Total	4,686

Acknowledgements

We are grateful to the following organisations and clients of Fulmer, who have kindly given permission for the reproduction of photographs in this review:

Boots Celltech Diagnostics Limited
Borden (UK) Limited
Draxtech Limited
Durapipe
Esso Petroleum Company Limited
European Space Agency
Harlow Chemical Company Limited
Hunting Composites
Martin—Baker Aircraft Company Limited
MUST (Multifrequency Ultra Sound
Technology)
Vickers Medical Limited

SERVICES TO INDUSTRY SERVICES TO INDUSTRY SERVICES TO INDUSTRY OF INDUSTRY SERVICES TO INDUST

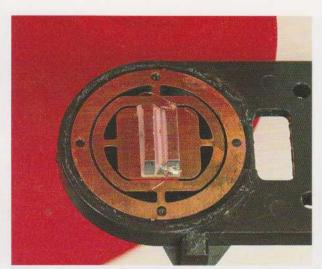
3



This keyboard incorporates Draxtech Limited membrane switches. Yarsley Technical Centre developed simulated service test equipment for these switches and confirmed that they functioned without deterioration for over one million operations.

Consistency and quality of electronic components and products are as important in consumer goods as they are in critical applications. Fulmer's floppy disc monitoring head, has been adapted from our successful tape abrasivity monitor to assess the abrasiveness of PC magnetic data storage media. The colour coded image of a Z-fold lasering cavity in alumina ceramic is an example of our work on high resolution ultrasonic inspection of ceramic packages for the electronics industry.

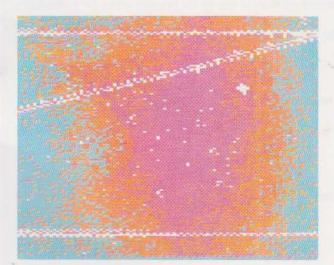
ELECTRONICS AND COMMUNICATIONS



Floppy disc abrasivity monitoring head.



DTI expert mission team.



Colour coded ultrasonic image of a Z-fold lasering cavity.

Fulmer's services to the electronics and communications industries include research on new electronic materials and devices, and their production for sale when appropriate, the development of sensors and design of supporting electronic equipment, aids to the manufacture of semiconductor materials such as boron nitride crucibles, and the testing of appliances and materials.

We have participated in UK Department of Trade and Industry and the Commission of the European Communities initiatives to stimulate the development and commercial exploitation of electrical and electronic materials. A member of our Yarsley Technical Centre staff joined a DTI supported expert mission to the USA to investigate the state-of-the-art on electroactive polymer technology. The mission team presented their findings at a seminar held in London in early 1987. In the fast developing and internationally competitive field of magnetic materials, Fulmer has cooperated in CEC programmes to research and develop alternatives to the A1NiCo and Nd-Fe-B alloys.

Throughout 1986 we have continued to act as a catalyst in the commercial exploitation of piezo-and pyro-electric polymers. Delegates from the UK and abroad attended a Fulmer seminar on applications of polyvinylidene fluoride (PVdF) to discuss developments in ultrasonic transducers, sensor cables, hydrophones, radiation pyrometers and medical devices. Many of the speakers were members of the PVdF Users Club, which Fulmer launched in 1985.

SERVICES TO INDUSTRY SERVICES TO INDUSTRY SERVICES TO INDUSTRY INDUSTRY SERVICES TO INDUSTRY SERVICES TO

5



Topside weight reduction for exploration and production installations offshore is one of the priority areas for technology, which the Offshore Energy Technology Board identified in 1986. Fulmer has been studying the opportunities for such saving through use of lightweight materials.

The building industry is, increasingly, adopting formal quality systems, registered to BS5750, the national quality standard.

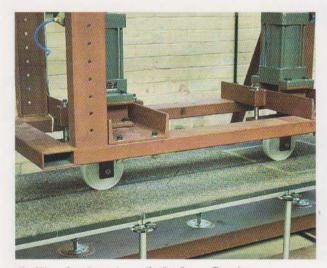
Durapipe, manufacturers of thermoplastic pipework systems, have been assessed and registered to BS5750 under the Yarsley Quality Assured Firms Limited Scheme.

Yarsley Technical Centre has added rolling load test equipment for platform flooring to its extensive facilities for testing building products.

ENERGY AND BUILDING



An ABS pipework system installed by Durapipe.



Rolling load testing of platform flooring.



Thermal transmission property testing.

Fulmer is mainly concerned with the material requirements of the energy industry, and with the development of processes which are energy efficient. For the building industry we provide a comprehensive range of testing services, including fire, insulation and weatherproofing, and undertake quality assurance and product certification.

Towards the end of 1986, Fulmer, in conjunction with Wimpey Offshore Engineers and Constructors Limited, won a Department of Energy contract to study lightweight materials for offshore applications. The future exploitation of marginal fields will depend on reductions in both exploration and installation costs. Weight saving, through more efficient engineering design and materials application, and improved equipment utilisation are the most obvious means of generating cost savings. Towards achievement of the latter, Fulmer has been applying advanced processing methods to develop novel material structures for drilling applications.

Many hundreds of companies in Europe produce double glazing panels. To assess variation in measured thermal transmission properties of these products, the Commission of the European Communities initiated a "round-robin" test programme in which Yarsley Technical Centre participated. The long term objective is to provide internationally accepted testing standards for product certification.

Yarsley Technical Centre is the principal UK testing authority on platform floors, designed for offices housing computers and similar equipment. In 1986 we undertook over 85% of all independent platform floor testing in the UK.

6

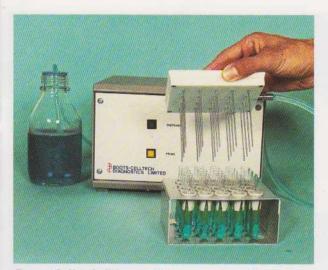
SERVICES TO INDUSTRY SERVICES TO INDUSTRY SERVICES TO INDUSTRY INDUSTRY SERVICES TO INDUSTRY SERVICES TO

7



The three instrument developments illustrated are examples of Fulmer's services to the healthcare industry. Vickers Medical's infusion pump uses a standard disposable syringe to deliver precisely metered fluids with a degree of accuracy essential in coronary care, anaethesia and chemotherapy. Yarsley Technical Centre manufactures production components for the pumps in its injection moulding facility. Boots Celltech Diagnostic's micro-dispenser incorporates novel valve and self-priming designs to dispense controlled volumes of reagent simultaneously to an assay of 20 test tubes. The ultrasonic skin scanner, featured in our Chairman's foreword, produces high resolution images for dermatological diagnostics, as shown on the front cover of this review.

HEALTHCARE



Boots Celltech Diagnostic's new micro-dispenser.



Ultrasonic skin scanning equipment.



Yarsley Technical Centre's injection moulding facility.

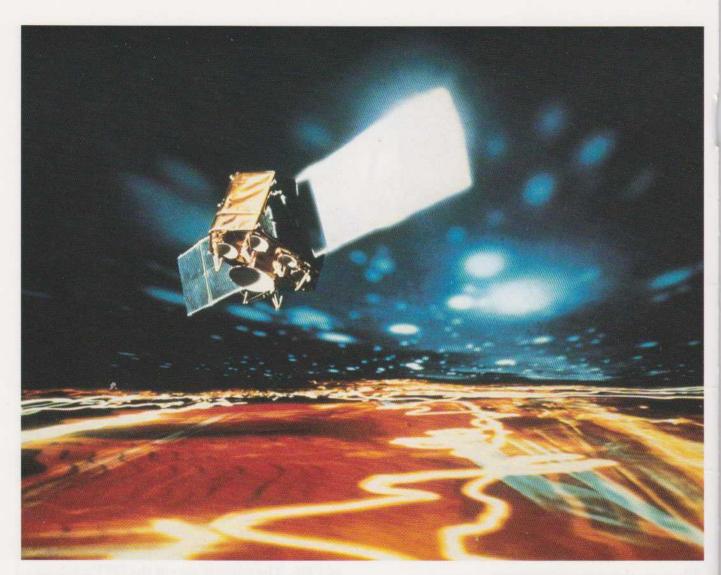
Fulmer's activities in healthcare have grown steadily as this industry has developed, worldwide. During 1986 we have assisted clients in the development of special equipment and sensors for patient monitoring and care, and have maintained our position as the leading supplier of special organo-fluorine pharmaceutical intermediates. Sales of the latter totalled £150,000, of which £70,000 was in the USA.

Yarsley Technical Centre has assisted in a major development in infusion pump technology introduced by Vickers Medical Limited, and the development and launch of a new micro-dispenser by Boots Celltech Diagnostics Limited. Both are precision instruments which required the selection of special polymers and the introduction of novel design features to meet performance specifications and to minimise production costs.

Diagnostics, surgery, rehabilitation, gerontology, nursing and drug manufacture and handling are all potential application areas for advanced robotics in medicine and health care. Fulmer is assessing these and other applications for the UK Department of Trade and Industry, in a feasibility study which commenced at the end of 1986. The study is part of the DTI's Advanced Robotics Initiative, and is one of 7 international projects in which the UK is participating.

SERVICES TO INDUSTRY SERVICES TO INDUSTRY SERVICES TO INDUSTRY DINDUSTRY SERVICES TO INDUSTRY SERVICES TO

9



The European Space Agency's Orbital Test Satellite provided invaluable information on the design and performance requirements of Europe's satellite programmes. Fulmer has contributed to the success of these programmes through its guideline documents on materials application in space environments.

The civilian helicopter turbine compressor module which failed in service, and the Martin-Baker Mk14 ejection seat are examples of products in which reliability and safety are critical. Fulmer has considerable expertise and experience in undertaking engineering assessments of this type of product, to ensure that the materials, processing routes and design will meet exacting performance requirements.



Failed helicopter gas turbine compressor module.

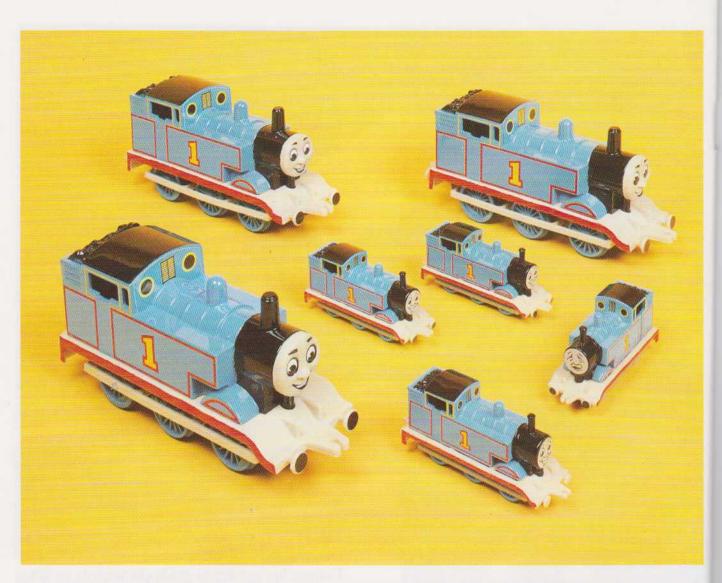


Martin-Baker's Mk14 ejection seat.

The defence and aerospace industries have been major market sectors for Fulmer over many years. They continue to be of importance to our business, because of the demand these industries create for new and advanced materials and processing, and the high reliability required of their products and components.

Aeroengine operation temperatures continue to rise to provide increased fuel efficiency and power to weight ratio, placing demands on new and improved high temperature materials. Fulmer has developed its expertise and facilities to meet this challenge, assisting clients throughout 1986 to produce improved ceramics by hot isostatic pressing and to inspect them using high resolution ultrasonics; to research oxidation-resistant inorganic composite structures; and to develop improved protective coatings for turbine components.

Fulmer's work for the space industry has been dominated by the advance programme requirements of the European Space Agency. 1986 was the sixth year of a continuing project for the European Space Agency to provide design guides on the application of advanced materials in space. Fulmer has produced guide documents on fibre reinforced plastic and metal matrix composites, beryllium and aluminium-lithium alloys, on processing technologies such as superplastic forming of metals and joining of composites; and on testing and inspection methodologies for advanced materials and structures.



Fulmer Research Laboratories and Yarsley Technical Centre maintain extensive facilities to provide services to consumer product manufacturers and users. The products on which we have advised range from car accessories to toys.

In the mechanical engineering industry, condition monitoring of machinery is becoming more important. Fulmer's Wear Debris Monitor, shown under evaluation at RHP Bearing Research Centre, has been developed to provide early warning of wear and lubricant contamination. The availability and reducing cost of pultruded fibre reinforced plastic sections are enabling the mechanical engineering industry to evaluate the use of lightweight composite structures, as an alternative to traditional metal fabrications.

CONSUMER PRODUCTS AND MECHANICAL ENGINEERING



A Fulmer Wear Debris Monitor under evaluation.



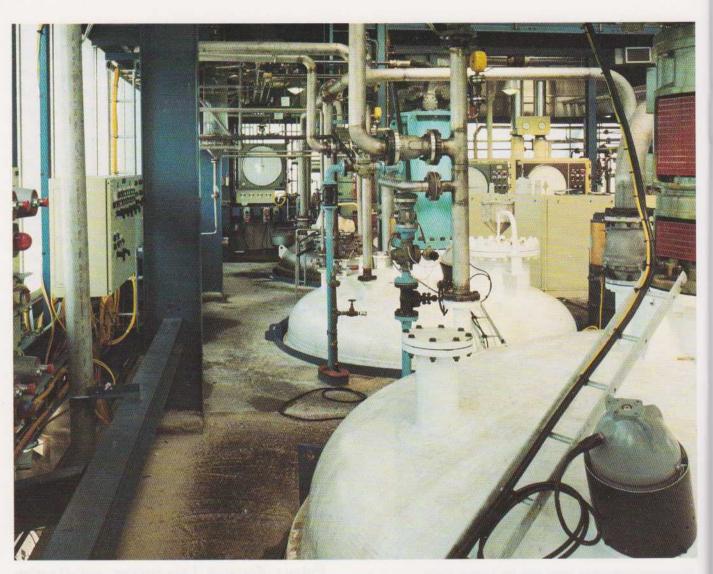
Prototype composite crane jib for Grove Coles.

Fulmer provides a wide range of services to the consumer products and mechanical engineering industries, including the design and development of new products and concepts, performance and safety testing, and the application of new materials and processes.

We have been developing a range of equipment to meet an increasing market demand for condition monitoring of fuels and lubricants. Wear debris and contaminants in these fluids is an indicator of machine health and potential catastrophic failure. Fulmer's Wear Debris Monitors incorporate thin film intrusive sensors which provide continuous on-line monitoring and respond rapidly to a change in system status. A number of major industrial organisation, including motor manufacturers, RHP Bearing Research Centre, British Rail Engineering Limited and BP Research Centre, have been evaluating Fulmer devices throughout 1985 and 1986. These trials have demonstrated that Fulmer's Wear Debris Monitors detect and provide early warning of the build-up of wear particles, indicative of abnormal wear damage, and the introduction of abrasive contaminants.

Fulmer Research Laboratories and Hunting Composites undertook a feasibility study, design optimisation and prototype production of a lightweight, fibre reinforced plastic composite, crane jib for Grove Coles. Composite pultrusions, joined by Hunting's Hi-Crimp fastening process which was developed at Fulmer, were used to construct the lattice section of the jib.

12



Harlow Chemical Company Limited, who operate the modern polymerisation plant at Stallingborough, South Humberside, shown above, are members of a consortium supporting work on computer modelling of emulsion polymerisation.

Yarsley Quality Assured Firms Limited has assisted companies, such as Borden (UK) Limited, in implementing Quality Management systems conforming to BS5750.

Yarsley Technical Centre provided design, materials assessment, product testing and quality control services to Esso Petroleum Company Limited in their programme to replace metal with fibre reinforced plastic for manhole covers on service station petrol tanks. Esso required the replacement covers to be light, to withstand loadings from tanker wheels, and to maintain their integrity in a fire.

CHEMICALS AND POLYMERS



Borden (UK) Limited's production facility at Peterlee, registered to BS5750: Part 2.



Esso delivery tanker.

During 1986 Yarsley Technical Centre continued to expand its services based on specialist knowledge in polymeric materials. These are called upon frequently by companies operating in the chemicals and plastics industry.

Yarsley Technical Centre, Fulmer Research Laboratories and Bradford University Polymer Research Unit have been co-operating on a major research project to develop computer software to model emulsion polymerisation reactions. The project is supported by a consortium of companies involved in the manufacture of emulsion polymers, including adhesives and paints. The computer programs will assist in optimisation and control of emulsion polymer production, and in the development of new copolymers, and predict the course of emulsion polymerisation reactions and properties of the polymers produced.

Yarsley Quality Assured Firms Limited (YQAF) received a grant from the Department of Trade and Industry to assist the development of its BS5750 certification service into the polymer industry. The close co-operation between YQAF and Yarsley Technical Centre staff, enabling integration of polymer specialists into assessment teams, was an important factor in attracting the DTI support. Both the British Plastics Federation and the Plastics Processing Industry Training Board supported this initiative and have nominated representatives to the YQAF Governing Board.

14



CONTRACT RESEARCH, DESIGN, DEVELOPMENT, CONSULTANCY AND TESTING IN MATERIALS TECHNOLOGY AND ENGINEERING

The Fulmer group constitutes four wholly-owned companies operating in the United Kingdom and three part-owned companies operating in the USA, Singapore and Southern Africa. Fulmer is a non-profit distributing body owned by the Institute of Physics. This guarantees its complete industrial and commercial independence.

The group employs more than 200 people, including 90 professionally qualified scientists, technologists and engineers.



Stoke Poges, Slough SL2 4QD Tel: Fulmer (02816) 2181 Telex: 849374 Fax: Fulmer (02816) 3178

Provides research, design, development, consultancy and technical services in metallic and advanced engineering materials, the structures and components manufactured from them, and the processes used. Special facilities and expertise include chemical vapour deposition for special ceramics coatings and components; comprehensive analytical, X-ray and electron microscope investigation; ion and electron emitting devices; novel non-destructive testing methods and systems; ballistic testing; radiation testing; and advanced metal processing and production engineering. The laboratory is NATLAS listed under registration number 0050.



Trowers Way, Redhill, Surrey RH1 2JN, Tel: Redhill (0737) 65070 Telex: 8951511

Provides research, design, development and evaluation services in non-metallic materials, and products and components which use plastics, rubbers, composites, paints, adhesives, timber, thermal insulating materials, floor coverings and building materials. Particular expertise exists in 'tailored' polymer technology, including polymer design and synthesis, coatings, film technology and composite materials. Special facilities include those for polymer research and processing; fire testing; fitness-for-purpose testing of building components; and thermal conductivity testing. Yarsley is a NATLAS laboratory listed under registration number 0036.



227 Berwick Ave., Slough SL1 4QT Tel: Slough (0753) 71356 Telex: 849374 Fax: Fulmer (02816) 3178

Manufactures high technology products including abrasivity monitors for recording tapes and lubricating fluids; special sensor systems and devices; pyrolitic boron nitride coatings and products in the form of crucibles, tubes and plates; delay units for computers; cable tension meters; and small batch, high precision engineering items. Fulmer's operations in the U.K. are located in South Buckinghamshire, Berkshire and Surrey.

Fulmer has 40 years experience of providing comprehensive services to industry, government agencies and commerce. The group is dedicated to assisting its clients to manufacture products and operate processes more profitably. We achieve this through our rapid response, technical excellence, integrated multidisciplinary approach and efficient transfer of technology.



PO Box 910 Englewood Cliffs New Jersey 07632, USA Tel: 201-568-7023

Provides access in the USA to advanced technology developed at Fulmer, and UK access to USA technology.



PO Box 48470 Roosevelt Park 2129, RSA Tel: 0102711 4821422 Telex: 4-24734

Provides research, development and technical services involving engineering materials and their application. Located in Johannesburg, the company has access to specialised equipment and expertise, both in South Africa and through Fulmer in the U.K.



520, Balestier Road, Singapore 1232 Tel: 250-1082 Telex: 23988

Provides testing and technical services in engineering metallurgy, including troubleshooting; materials evaluation and consultation; materials selection; technical data search; and corrosion protection advice.



Yarsley Quality Assured Firms Ltd. (YQAF)

Trowers Way, Redhill, Surrey RH1 2JN Tel: Redhill (0737) 65070 Telex: 8951511

Yarsley Quality Assured Firms (YQAF) Ltd. is a certification body dedicated to the universal promotion of quality. YQAF offers certification schemes as follows:—

Quality Management Systems Certification (Registration to BS 5750) Assessment and certification of an applicant's Quality Management Systems which conform with the requirements of the appropriate Part of BS 5750: 1979 'Quality Systems'. Product Conformity Certification (Testguard) Certification of the product following assessment and testing for conformance with relevant technical specifications in addition to assessment

of the Quality Management Systems.