

J. F. Herbst,  
IRSD.



CSIR 

The logo for the Council of Scientific and Industrial Research (CSIR) of India. It features the acronym 'CSIR' in a bold, sans-serif font, followed by a square icon containing three parallel, slanted lines that converge towards the top right corner.

NEW DELHI

A faint, large-scale watermark or embossed text that reads 'NEW DELHI' across the middle of the page. The text is light and appears to be part of the paper's design or a watermark.



**COUNCIL FOR SCIENTIFIC  
AND INDUSTRIAL  
RESEARCH**

**thirtieth annual report  
1974**

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# MEMBERS OF THE COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

## 1974

**Dr C v d M Brink** - Chairman  
President of the CSIR

**Prof. A J Brink**  
President  
South African Medical  
Research Council

**Mr M T de Waal**  
Joint General Manager  
Industrial Development  
Corporation of South Africa Ltd

**Prof. C A du Toit**  
Professor of Zoology  
University of Stellenbosch

**Dr B Gaigher**  
Member  
Board of Trade and Industries

**Mr G C V Graham**  
Managing Director  
Fine Wool Products  
of South Africa Ltd, Uitenhage

**Dr J N van Niekerk**  
Head  
Basic Research Division  
Research Department, ISCOR

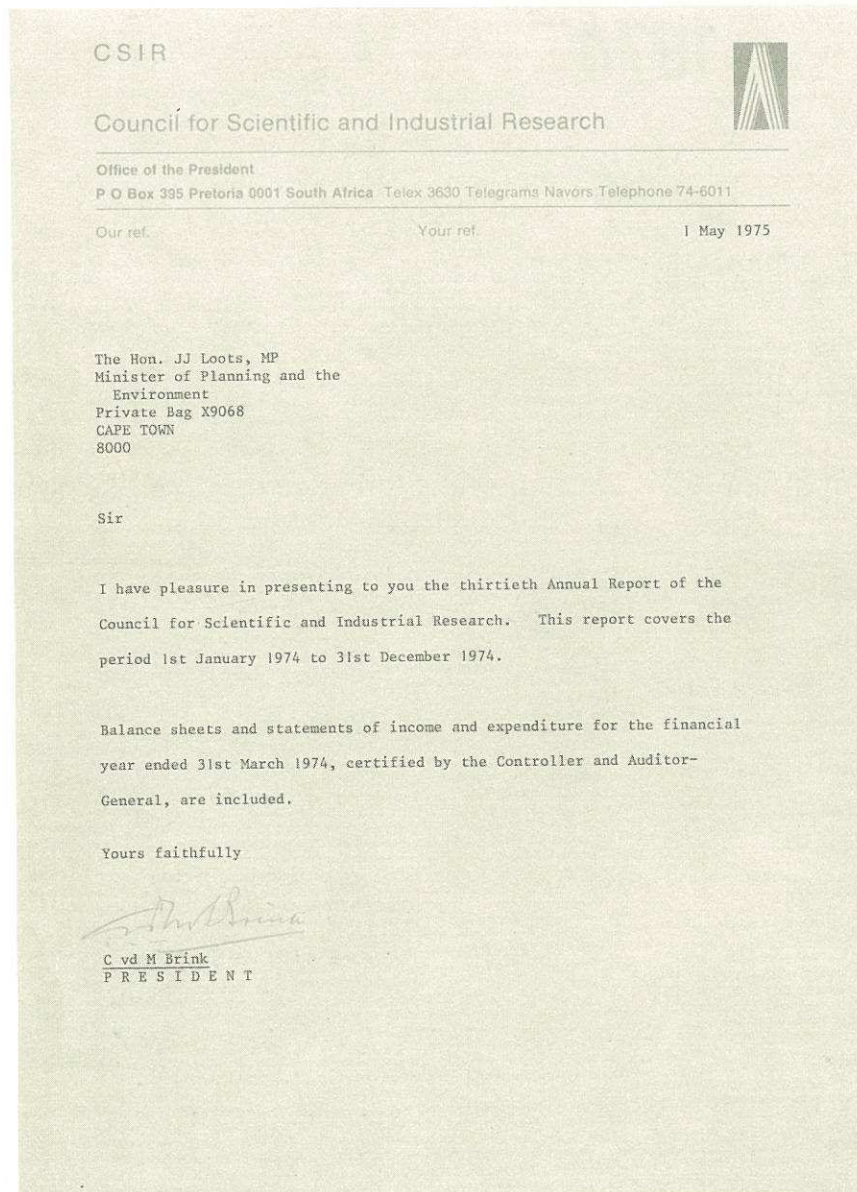
**Dr A J A Roux**  
Chairman  
Atomic Energy Board

**Mr J W Shilling**  
Director  
Anglo American Corporation  
of South Africa Ltd

**Prof. E J Woodburn**  
Head  
Department of Chemical  
Engineering, University  
of Natal

**Dr P S Rautenbach**  
Secretary, Department of Planning  
and the Environment

**Dr L B Knoll**  
Managing Director  
Massey-Ferguson South Africa Ltd





## the year in retrospect

### New Institute



Dr C vd M Brink, President

A major event during 1974 was the establishment of the National Research Institute for Oceanology in February with headquarters at Stellenbosch. This Institute, under the directorship of Dr ESW Simpson, formerly professor of Geology at the University of Cape Town, combines all aspects of marine science in which the CSIR is engaged — notably physical oceanography and coastal engineering.

At the official opening of the new Institute, which took place on 13 August 1974, the Minister of Planning, the Hon JJ Loots, emphasized the importance of research in oceanology for South Africa, which has a coast line of almost 3 000 km and faces onto three oceans — the Indian Ocean, the Atlantic Ocean and the Southern Ocean. Mr Loots also referred to the international character of oceanography and to the role played by the South African National Committee for Oceanographic Research (SANCOR) in co-ordinating activities on a national level and maintaining links with international research in this field.

### International co-operation

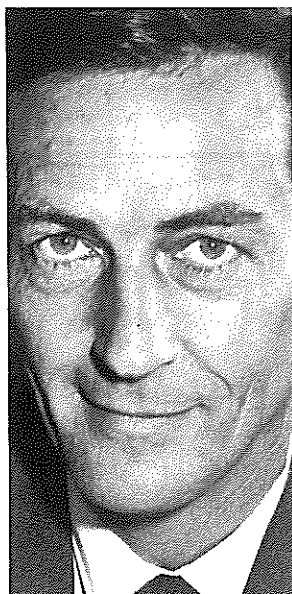


Dr FJ Hewitt, Deputy President

At the fifteenth General Assembly of the International Council of Scientific Unions which was held in Istanbul during September 1974, South Africa was represented by the President of the CSIR, and two senior staff members. The CSIR also sponsored the attendance of several South African scientists at the business meetings of other ICSU organizations including the General Assembly of the International Mathematical Union in Vancouver and meetings of the Inter-Union Commission on Geodynamics in Zurich and Regensburg.

The year 1974 saw the final stage of a major collaborative venture, with the closing of the Deep Space Facility (DSF) at Hartebeesthoek which had been successfully operated by the CSIR on behalf of the United States National Aeronautics and Space Administration (NASA) for many





Dr JF Kemp, Vice-President

years. According to plan the DSF continued full operation up to the end of June 1974 when operations ceased. Since then the staff were gradually phased out while carrying out the final dismantling and packing of items of equipment which are to be returned to the USA or sent to other parts of the Deep Space Network. The packing operations are well under way and are expected to be completed shortly. Practically all the staff members concerned have found suitable alternative positions in the CSIR or elsewhere.

It is expected that the Satellite Tracking Station (STDN) at Hartebeesthoek will cease operation at the end of 1975. As in the case of the DSF, full-scale operation will continue until the date on which the station is closed.

Plans for continuing and considerably expanding the radio astronomy programme at Hartebeesthoek are well advanced. A radio astronomy group is being built up and facilities are being prepared.

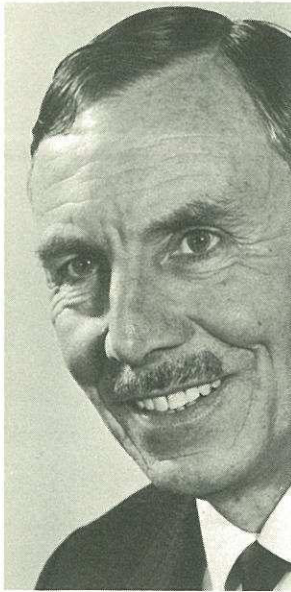
In terms of an intergovernmental agreement (announced in 1973) between South Africa and France the CSIR on 1 April 1974 assumed full responsibility for the operation of the French tracking station at Paardefontein near Pretoria which had been established and operated since 1965 by the Centre National d'Etudes Spatiales (CNES). During September, the President of the CSIR visited the CNES at Toulouse in France.

Another major collaborative venture, the operation of the South African Astronomical Observatory (SAAO) by the CSIR in conjunction with the Science Research Council of the United Kingdom, is well underway. During the year an important additional facility for the SAAO was acquired when the CSIR purchased the 74-inch telescope at the Radcliffe Observatory, Pretoria, from the Radcliffe Trustees. Towards the end of 1974 the telescope was moved to the SAAO observing station at Sutherland and it is hoped that it will be re-erected and made operational towards the end of 1975.

#### Regional liaison

An important development in the regional activities of the CSIR was the establishment of a Western Cape Regional Committee for Scientific Research which held its inaugural meeting in Cape Town in June 1974. This Committee was formed to further scientific and industrial research in the



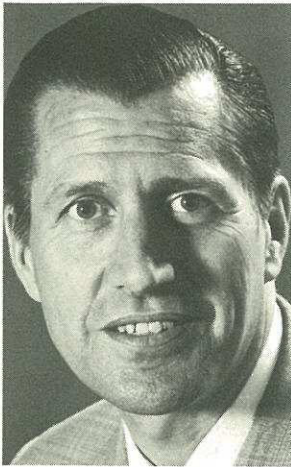


Dr PJ Rigden, Vice-President

Western Cape, to promote co-operation between the CSIR and commercial and industrial interests, the universities and agencies of central, provincial and local government in the Western Cape, to consider reports of work done by CSIR institutes for the Cape Provincial Administration and for other organizations, to make recommendations on the co-ordination and continuation of research programmes, and to give publicity to research activities. This committee follows the pattern of long-standing CSIR regional research liaison committees for Natal, South West Africa and the Eastern Cape.

In conjunction with this meeting, which was attended by representatives of the various agencies involved, an exhibition of CSIR activities in the Western Cape was held.

#### Industrial research



Dr AP Burger, Vice-President

Developments in the sphere of industrial research included the establishment by the CSIR of an Automation and Production Technology Service (APTS) to provide a central channel of communication between enquirers seeking advice on automation and production technology problems and those organizations both within and outside the CSIR which can assist in the solution of such problems. This service caters particularly for the small and medium-sized manufacturing firms which lack the know-how and/or financial resources to undertake their own investigations in such problem areas. Many activities of the CSIR have a bearing on automation and production technology and the APTS can ensure that the relevant facilities and expertise are brought to bear on particular problems experienced by industry.

The quinquennial review by the Advisory Committee for the Development of Research for Industry (ACDRI) of the activities and financing of the Leather Industries Research Institute, Grahamstown, took place during the year. A detailed techno-economic review of the leather and related industries and of the Institute's activities indicated that valuable contributions in the development particularly of the hides and skins, tanning and wattle industries, merited continued financial support by the CSIR for a further five-year term.

The industrial subscribers to both the Sugar Milling Research Institute, Durban, and the Fishing Industry



Research Institute, Cape Town, agreed to increase their annual contributions in order to meet increased salary costs. However, industrial subscribers to the South African Paint Research Institute, Durban, could not see their way clear to making a similar increase in their annual contributions. As increased staff costs without a corresponding increase in income would reduce the scale of operations below the level considered necessary for the conduct of an effective research and development programme, the Board of Control had reluctantly to decide that the Institute should be closed at the end of December 1974. The South African Paint Research Institute was established in 1948 at the University of Natal, Durban, as a joint venture financed by the CSIR and the South African paint industry.

CSIR facilities in the field of textile research were extended with the opening of a new cotton processing division at the South African Wool and Textile Research Institute in Port Elizabeth on 1 May 1974. In conjunction with the opening ceremony, which was attended by several leading personalities in the cotton industry in Southern Africa, a symposium on cotton production in Southern Africa, mechanical harvesting and ginning, cotton grading and cotton processing was held.

#### Grant-supported research

The CSIR continues to play an important role in supporting research at universities and museums. For the financial year 1973-74 a total amount of R1 667 000 was made available to research workers at these institutions.

Unfortunately the CSIR has found it impossible to meet all deserving requests for funds, as recommended by its referees and committees for the various disciplines. It should be pointed out, however, that the Government has always reacted favourably to well-motivated representations for additional funds for this purpose, and that the amount voted annually for research grants has grown at a much faster rate than the funds provided for the CSIR's own research institutes and laboratories.

#### New appointments

Dr Leon B Knoll, a prominent engineer, industrialist and businessman, was appointed to the Council of the CSIR for a



three-year term with effect from 1 January 1974 to fill the vacancy caused by the retirement of Mr JD Roberts after nine years of service on the Council. Apart from his many business interests, Dr Knoll has been a member of the Prime Minister's Economic Advisory Council since its inception in 1960 and he is also a member of the Government Commission of Inquiry into Exports and of the Export Advisory Council as well as of many other important organizations concerned with national affairs.

Another appointment to the CSIR Council was that of Dr PS Rautenbach, Secretary for Planning and the Environment. Dr Rautenbach, whose appointment took effect from 1 January 1974, replaced Dr PJ Riekert, Economic Adviser to the Prime Minister.

Prof ET Woodburn of the University of Natal, Dr AJA Roux of the Atomic Energy Board and Mr MT de Waal of the Industrial Development Corporation were reappointed as Council members for a further three-year term.

The appointment of Prof DH Jacobson, with effect from 1 January 1975, as director of the CSIR's National Research Institute for Mathematical Sciences, was announced during the year. Prof Jacobson, formerly professor in the Department of Applied Mathematics at the University of the Witwatersrand, succeeds Prof C Jacobsz who retired in December, 1974. Prof Jacobsz will remain at the CSIR for special duties.



# chemical research

## NATIONAL CHEMICAL RESEARCH LABORATORY

Director - DR P R ENSLIN

The National Chemical Research Laboratory (NCRL) serves as a centre where the latest developments in chemical science are brought to bear on problems of national significance.

In accordance with a policy of concentrating on research in fields where a need for more basic knowledge exists, many of its research projects are carried out in collaboration with research organizations that are more directly concerned with the practical problems involved. Well-motivated long-term projects are, therefore, approached from a fundamental point of view.

The NCRL is organized into divisions of analytical chemistry, biological chemistry, inorganic chemistry, organic chemistry, molecular biochemistry, physical chemistry and corrosion research. The physical chemistry division is also part of a chemical physics group which operates in conjunction with two divisions of the National Physical Research Laboratory. In addition the Laboratory included a Bantu Beer Research Unit, which was transferred to the National Food Research Institute in 1974.

### Pharmacologically active substances

A new aspect of the continuing programme of the synthesis of branched-chain sugars and nucleosides is the preparation of substances containing a fluorine atom at the branched point. These carbohydrate derivatives will be screened at the National Institutes of Health in the USA as it is known that certain fluorinated nucleosides are powerful anti-tumour agents.

The  $9\beta$ -methyl analogue of retroprogesterone has been synthesized by the application of a novel method for side chain incorporation, which was recently developed in the laboratory. The hormonal activity of this substance is currently being evaluated at the Schering Corporation in the USA, with whom this laboratory has a contractual agreement.

### Metabolites of poisonous fungi

The continuing collaboration with the National Research Institute for Nutritional Diseases of the Medical Research Council has led to further progress in the isolation and structural elucidation of new metabolites. Six novel bisdihydrofurans isolated from *Aspergillus ustus* have been studied and it has been shown that some exhibit higher cytotoxicity than the structurally related metabolite, sterigmatocystin.

A novel mammalian metabolite of aflatoxin B<sub>1</sub> has been identified, and a collaborative study with Prof G Kirby of the University of Glasgow on an aspect of the biosynthesis of cyclopiazonic acid has been completed.

### Proteins

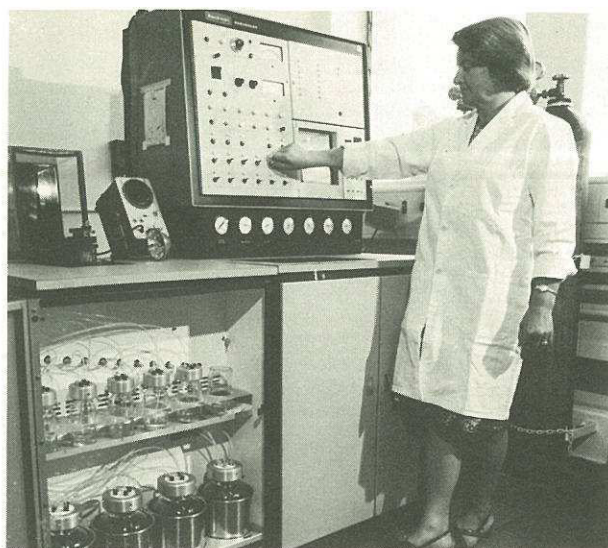
Although the NCRL played a leading role in the elucidation of the primary structure of snake venom neurotoxins, knowledge regarding the functional aspects of these molecules lagged behind. Recent advances made in this laboratory on cytotoxin and phospholipase A structures, however, opened a new field for structure-function relationship studies. These latter molecules are known to act synergistically on the cell membrane, liberating membrane-bound enzymes. A study of the action of these molecules, with known structure, now forms part of a broader study of membrane structures.

Progress made in the field of phosphoproteins also allowed functional studies to be initiated. The phosphitins, from various sources, now act as substrates of known structure for a study of the biosynthesis and metabolism of these compounds.

### Digestion and metabolism of ruminants

Work relating to the digestion and metabolism of ruminants is carried out in close cooperation with the Veterinary Research





Determination of the linear structure of a protein requires the sequential degradation of the protein and the identification of the released amino acid derivatives. The sequencer shown in the photograph automatically, through many steps of each cycle involving the introduction of various chemicals to the protein under investigation, sequentially degrades the protein, leaving only the identification of the released amino acid derivatives to be done manually.

Institute at Onderstepoort. The major part of the work is still concerned with the digestion of high-fibre diets and the metabolism of the resultant end-products by sheep. These studies are beginning to provide some clues as to how the rumen flora can be manipulated to allow the most effective fibre-digesting bacteria to achieve their maximum growth potential. This affects the rate and extent of fibre digestion in the rumen and thereby the performance of ruminants under range conditions or on maintenance diets.

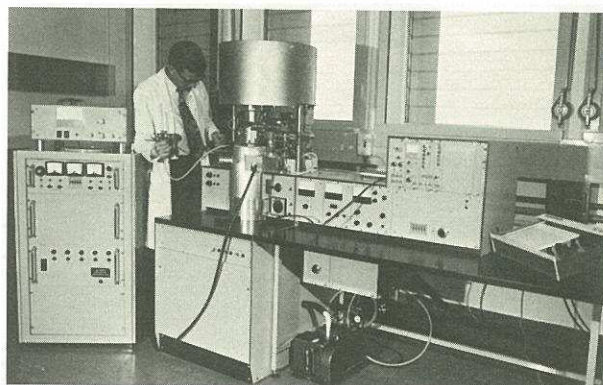
However, even under optimum conditions, fibre digestion is a relatively slow process that does not provide energy at a sufficiently high rate to keep pace with the production potential of, e.g., lactating dairy cows or slaughter animals in the finishing-off period. Therefore part of the work is being directed to the study of digestion and metabolism in ruminants on high-concentrate diets. A major problem here is the maintenance of a balanced ruminal flora which produces energy nutrients in the form of volatile fatty acids, in the proportions in which they occur in animals on high-roughage diets, without accumulation of lactic acid which is undesirable in every way.

#### Surface chemistry

Photoelectron spectroscopy is a new technique which measures the binding energy of electrons, and is a very versatile analytical tool since all chemical elements can be detected in either the gas or solid phase. With the recent acquisition of an AEI ES-200B photoelectron spectrometer by the NCRL this technique has now become freely available in the Republic.

Exploratory studies have been undertaken for the Laboratory's Corrosion Research Division to study the reaction of carbon monoxide and hydrocarbons with iron surfaces and for the National Institute for Metallurgy on the chemical products formed on the surface of platinum group metal electrodes.

Manganese oxides used in dry cells and some laser glass materials have already been analysed for the Chemical Engineering Research Group and the National Physical Research Laboratory.



The AEI ES-200B Photoelectron Spectrometer recently acquired by the NCRL. Photoelectron spectroscopy is a new technique for measuring the binding energy of electrons, and is a very versatile analytical tool since all chemical elements can be detected in either the gas or solid phase.

#### Corrosion

Both external and internal corrosion of metal pipes continues to be a major problem and half of the research activities of the Corrosion Research Division was devoted to these fields. As far as internal corrosion is concerned, the main objective of this project is to develop a method by which the corrosion in a steel or galvanized pipe conveying a particular water under specific conditions could be continuously monitored.

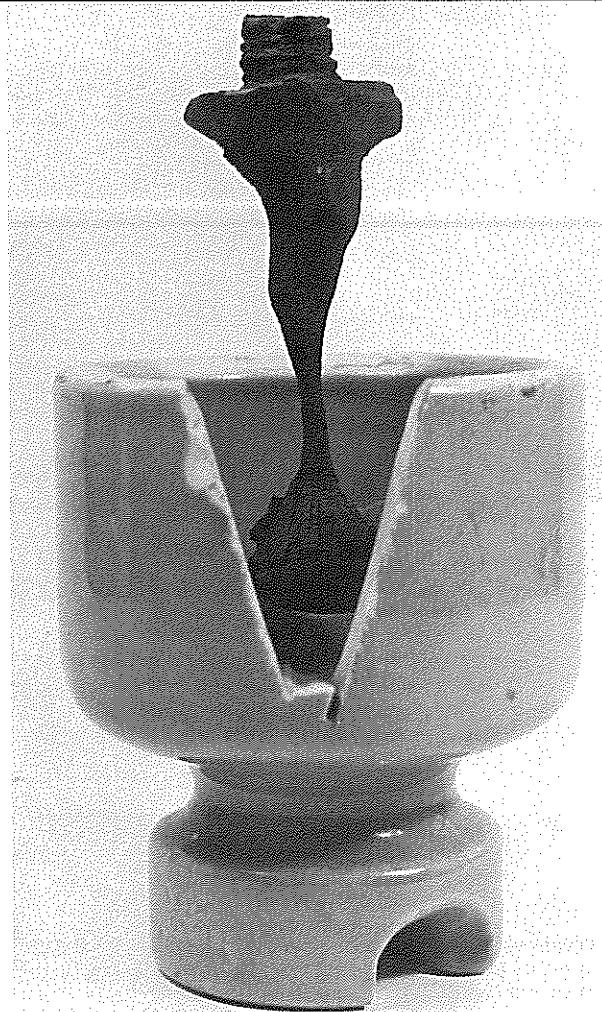
Tests with the available commercial apparatus have shown it to be subject to serious design errors making it undependable. Other methods based on the polarization resistance principle are now being developed for field use. If this is successful, it will be possible to continuously monitor corrosion rates in a given system. The advantages of this to the control of anti-corrosion water treatment are obvious. In addition, spool pieces of either galvanized steel or black steel have been designed for installation in water reticulation systems where trouble is being experienced. By means of these spool pieces the corrosivity of the water and the effect of temperature and pressure as well as the behaviour of a galvanized coating could be studied in detail with time.

For closed-circuit cooling systems a rapid method has been developed to determine the minimum effective concentration of inhibitor necessary to provide protection to steel surfaces in a particular water. This method is now being extended even further to determine the relative corrosivity of domestic waters by recording the concentration of inhibitors required to cause passivity of steel.

External corrosion of buried pipes due to oxygen differential cells in variable clay soils and bacteriological action is being investigated. An exposure programme to study the behaviour of stainless steel in clay soils in the presence of sulphate-reducing bacteria has been initiated.

Corrosion of mild steel exhaust systems in the automotive industry is costing the country an estimated R12 million per an-





Insulator body cut away to show damage to steel pin caused by corrosion in a marine environment. The Corrosion Research Division is investigating various corrosion problems in order to establish suitable remedial measures.

num. On the basis of published information on the composition of exhaust gases this type of corrosion is being studied by special methods to evaluate different types of steel and metal coated steels in terms of their corrosion resistance.

#### Analytical chemistry

The Analytical Chemistry Division has, after three years, completed a systematic study of the ion-exchange behaviour of 55 elements in HBr-acetone media; this includes the determination of more than a thousand distribution coefficients. This information is of the greatest importance for the development of selective procedures for the separation of elements from complex mixtures such as rocks.

A method for the determination of trace and ultra-trace amounts of lanthanides in rock was developed in collaboration with the National Physical Research Laboratory, and has been applied successfully to the analysis of 170 rock samples from the Geological Survey, as part of their study of the genesis of the Bushveld complex.

#### Platinum metals

Recent work has shown the specific effect of the solvent in governing the intermediate, and, consequently, the final products in isomerization reactions of platinum compounds. With iridium, the size of the groups bonded to the metal has been shown to be the major factor controlling product formation. Many of the important intermediates in these reactions have been characterized — some by X-ray crystallographic structural determinations done in conjunction with the University of Natal.

X-ray determinations of iridium-oxygen systems, now completed, may lend some insight into the factor governing reactivity of oxygen in oxygen transport systems. Ruthenium is probably the most neglected of the platinum metals and the Inorganic Chemistry Division has embarked upon a study of the chemistry of this metal with the two-fold aim of extending its limited chemistry and of finding new uses for the metal. The uses of new ruthenium salts as catalytic reagents are under investigation.

Results obtained in respect of the reactivity of gold towards sulphur-containing reagents has awakened much interest at the Chamber of Mines of South Africa. The use of xanthates for iron pyrites removal from gold ores causes a drop in gold extraction and hence the reactivity of gold towards xanthates and other sulphur-containing groups is under scrutiny.

#### Bantu beer

The coming independence of the Black Homelands has focused attention on their technical and economic needs. The development of industries and their supporting infrastructure is obviously of prime importance. The Bantu Beer Unit, in an attempt to contribute to this very necessary development, invited the various Homeland leaders to spend a day with the Unit.

After an introductory talk by the President of the CSIR a detailed presentation was given of the economic and technical services provided by the Unit for the Bantu beer brewing industry. At the conclusion of the meeting a spokesman for the Homeland leaders made a formal request to the CSIR for aid in developing the sorghum beer industry.



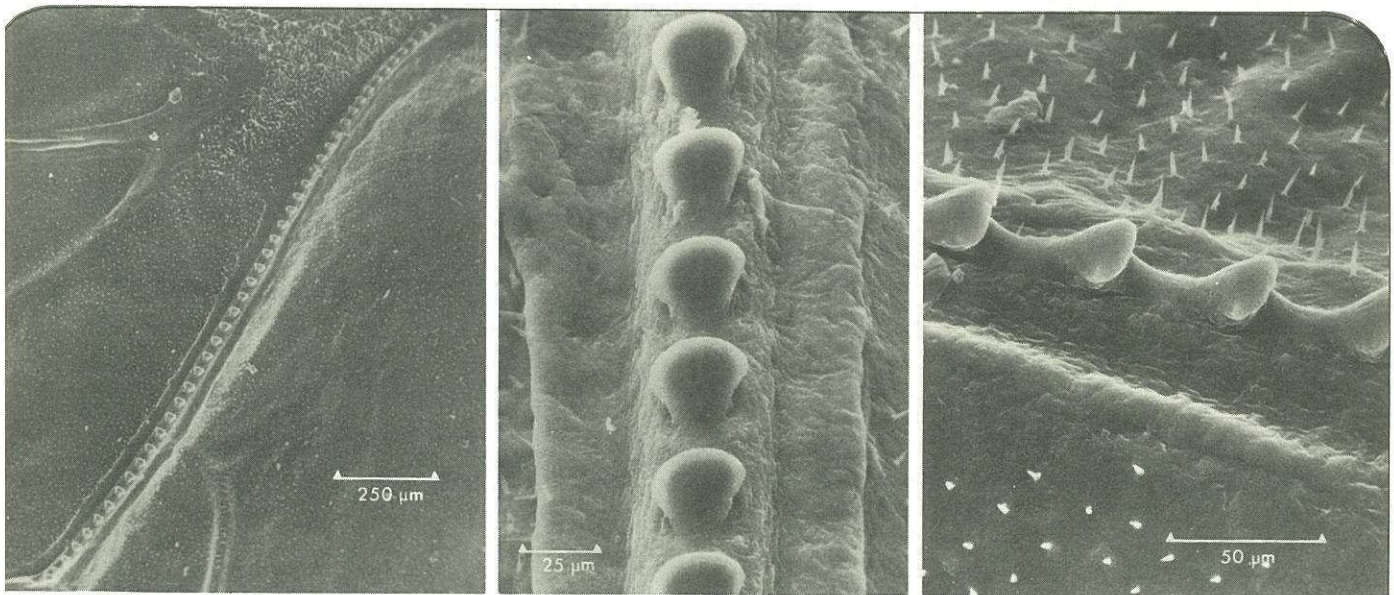
# physical research

## NATIONAL PHYSICAL RESEARCH LABORATORY

Director - DR A STRASHEIM

The main function of the National Physical Research Laboratory (NPRL) is to contribute to the development of physical science in South Africa through research aimed at the adaptation of existing knowledge as well as the discovery of new facts of value in the solution of technological and industrial problems of national importance. In addition, the NPRL has statutory responsibilities for maintaining national standards of physical measurement for mass, length, electricity, radiation, etc.

The present facilities of the NPRL cater for most of the important needs of the Republic in the sphere of physical science. Within the NPRL there are groups of research workers in the fields of earth physics, applied physics, nuclear science and materials science.



Using apparatus such as the scanning electron microscope the NPRL continued to render specialized services to industry, universities and other organizations. Shown here is a series of scanning electron micrographs of the sound-producing organ (stridulatory file) of a tree-cricket.

### Services

Every group within the Laboratory continued to render important services to industry, universities and other organizations. In this respect, apparatus such as the scanning electron microscope, the automatic single crystal diffractometer and mass spectrometers for radiometric dating proved their worth.

Apart from the data provided by these instruments carbon dating, spectroscopic analyses, study of materials under high pressure, production of medical isotopes, investigations related to air pollution, optical services and standardization activities are examples of direct assistance that has been provided by the NPRL for outside bodies.

## Energy

The implications of the present energy crisis on the CSIR research programmes, especially as regards alternative motor fuels — the main problem facing South Africa as a result of the world fuel situation — were discussed at an internal conference held during February. Certain aspects in which the NPRL could undertake research of significance came to the fore, and a programme in connection with hydrogen technology, namely the development of hydrogen-absorbing materials and devices, has been initiated.

### Ion microprobe mass analyzer

In view of the high priority assigned to metallurgy, considerable attention has been devoted to certain aspects of physical metallurgy.

The role of the surface is important in defining the physical properties of the material. In the past, surface studies were carried out by means of scanning and Auger electron microscopy. The recent development of the ion microprobe mass analyzer (IMMA) has introduced a new dimension into surface studies. Ion microprobe mass analysis makes use of a focused beam of ions to sputter secondary ions from a microvolume of the sample surface. Subsequent mass analysis of these secondary ions permits quantitative elemental pictures to be constructed for the microvolume. The method is extremely sensitive and even elements present at trace levels in the microvolume can be detected.

Such an instrument has been purchased to augment the array of existing equipment at present in use at the NPRL in this field. In addition to problems in physical metallurgy, attention will be focused on catalysts, thin films and geological samples — all of which are within the scope of the new instrument.

### Absolute radiometer

The scientific world is at present considering the replacement of the platinum radiator as the unit of light. The radiometric approach to the realization of the new unit of light is a novel one which offers definite advantages and higher accuracies than the platinum radiator method.

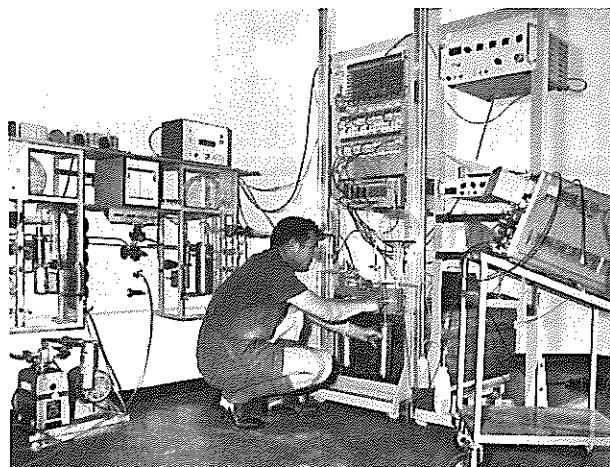
The radiometer is a sophisticated instrument which can be operated in vacuum and at low temperatures. This will ensure high stability and accuracy. Apart from the unit of light, the instrument will also be used for basic research in radiation physics. The construction of a radiometer for this purpose is almost complete.

### High power gas lasers

The established double-discharge principle of stabilizing transversely excited infrared lasers at atmospheric pressure has been extended to high pressure ultraviolet-emitting molecular systems operating on nanosecond time scales. Use is made of a Blumlein-type circuit to generate the high power nanosecond electric pulses. Thus far arc-free nitrogen discharges and lasing action in the ultraviolet have been obtained at pressures in excess of 50 kPa.

### Textile fabrics

A photo-electric device was designed to give quantitative estimates of barré (a textile fabric defect appearing as long stripes of non-uniform colour due to uneven dye uptake) and streakiness (shorter stripes due to dye effects, irregularity in knit or weave, or puckering). The image of an illuminated slit is focused onto a sample of a fabric which is moved at constant speed. Detectors observe transmitted light as well as the green



Equipment in the carbon dating laboratory located 15 m underground to reduce stray background activity.

and infrared components of the reflected light by means of an integrating sphere. Suitable comparisons of these signals yield quantitative measures of the various types of fabric defects.

### Optical design

Optical design capabilities at the NPRL have been expanded through the purchase of the Accos V automatic design program. Design of complex lens systems including zoom lenses and evaluation of lens types using a diffraction calculation of the optical transfer function are now possible. The construction of a prototype (100 mm, f/1.0) catadioptric objective has been completed. The prototype lens has been fully evaluated and the measured optical properties have been found to be in very close agreement with the theoretical predictions.

### Geophysical studies

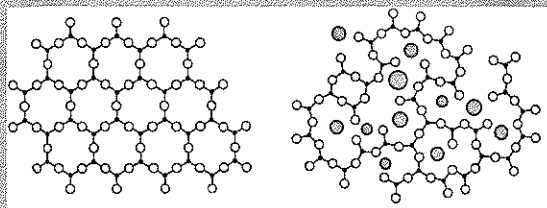
The Geophysics Division is undertaking geophysical and geohydrological studies in areas covered by sands and sediments of the Kalahari System. Work has thus far consisted of deep electrical soundings to study the electrical properties of the Kalahari together with an analysis of borehole results. About 200 of these soundings have been carried out.

It has been possible from these data to delineate in one area two waterbearing formations within the Kalahari succession, termed the Middle Kalahari and Basal Kalahari. Although existing borehole information is relatively scarce and sometimes unreliable, it has been recognised that water from the Basal Kalahari is generally brackish while that from the Middle Kalahari is of better quality. The resistivity of the Middle Kalahari formation as deduced from the sounding results can be correlated quite well with the borehole yield of water. This correlation will be studied in a selected area where test boreholes are to be drilled.

### Inductively coupled plasma

A study of the inductively coupled plasma technique to assess its capabilities as an emission source for optical analytical





Photochromic effects in rare earth doped glasses have been investigated as part of a programme concerned with the development of laser glasses. The diagram shows typical arrangements in a crystal (left) and a doped glass (right).

spectrometry is being undertaken. The technique has been shown to be suitable for simultaneously determining a number of important elements in geochemical soil samples, and has the further advantage of excellent sensitivity, wide range linear response and comparative freedom of chemical interferences for many elements.

Further research is planned on the application of this technique to the analysis of plant materials and ferrous ores, as well as fundamental investigations of physical interference effects. Considerable interest has been shown by commercial laboratories, where sample throughput could be increased by the use of this method above existing single element methods.

#### High-pressure phase relations of potentially important materials

The phase properties of selected examples of groups of potentially important materials have been studied. Some 30 new phases were isolated and identified in the series of binary systems between  $\text{In}_2\text{O}_3$  and the rare earth oxides. These included some perovskites, which are of interest as laser materials, and also a totally new class of substances of which the properties still have to be investigated, but which may be useful electroluminescent materials.

#### Photochromic glasses

Photochromic effects in rare earth doped glasses have been investigated as part of a programme concerned with the development of laser glasses. The speed of reversion in some of the glass systems studied was found to depend on the erbium oxide concentration. By optimizing this effect, a glass has been discovered for which the reversion time was four times faster than the fastest hitherto known. Photochromic glass with very fast reversion times finds application as protective windows on photosensitive devices and as fast optical read-in inputs for computers.

#### Alpha clustering

The CSIR's cyclotron — a first generation type of cyclotron — is, apart from providing an essential service to nuclear medicine through the production of otherwise unobtainable radioactive isotopes, the only cyclotron of its kind in the world still extensively being used for fundamental nuclear physics research. One of the fields of research is the alpha-clustering model of the nucleus. According to this model correlated groups of four nucleons exist in the nuclear interior — these clusters corresponding to physical alpha-particles only when they are actually removed from the nucleus.

During the past year studies have been made of alpha elastic and (helium-3, alpha) pickup reactions on the even isotopes of nickel to investigate the existence of alpha-clusters in the surface of these nuclei. In contrast to previous elastic scattering experiments on light nuclei the elastic scattering on the nickel isotopes do not give evidence of appreciable alpha-clustering. The results of the (helium-3, alpha) reaction, however, may well be interpreted in terms of an alpha-cluster knock-out from the nucleus. This indicates that the two different types of reactions employed in the study probe different properties of the cluster structures in the nuclei that were studied. This dual approach could lead to more information about the clusters themselves.

#### Mercury and pollution

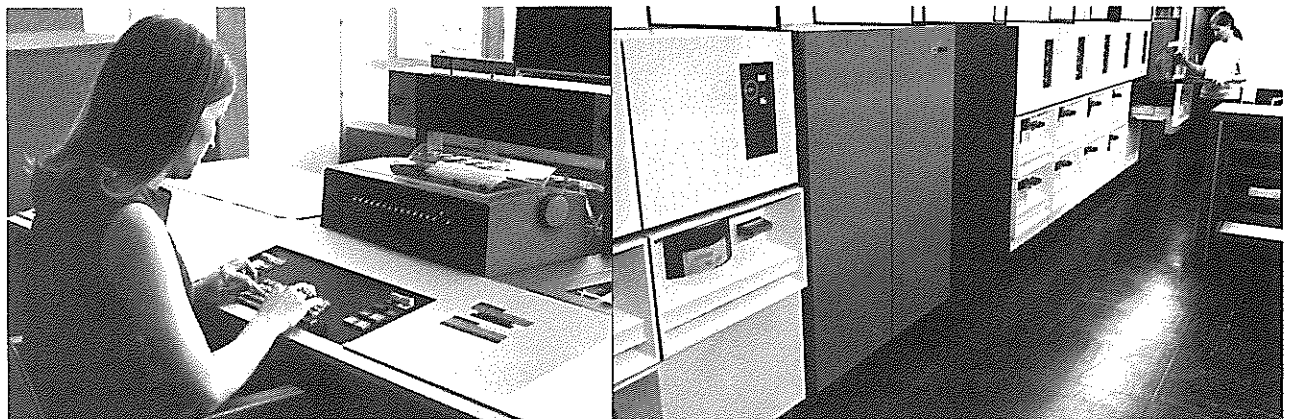
Mercury is known to be a highly toxic metal even when present in extremely low concentrations. The ability of organisms (often forming part of the food chain) to accumulate this element makes it important to be able to determine its presence in water and other environmental samples at concentrations as low as microgram per litre or subnanogram levels. A technique which includes the separation of the mercury from the water with silver wool and determining the mercury spectroscopically has been developed by the Laboratory. The technique allows easy sample collection and transport. In comparison with other methods it is more than 100 times more sensitive while having a precision at least as good. The added convenience of not having to preserve, store and transport bulky samples to the laboratory makes it highly practical.

# mathematical sciences

## NATIONAL RESEARCH INSTITUTE FOR MATHEMATICAL SCIENCES

Director - PROF. C. JACOBSZ

The National Research Institute for Mathematical Sciences (NRIMS) consists of divisions for mathematical analysis, numerical analysis, computer science, operations research and statistics, and a computing centre. Activities cover the various branches of mathematics and their application to research. Typical fields of study are theoretical fluid dynamics, statistical decision techniques and design of experiments, and numerical and non-numerical computation on digital computers.



To cope with the continually increasing demand for computing services in the CSIR, the system employed in the computing centre had to be expanded. The centre recently became a separate division of the Institute.

### Dynamical meteorology

A detailed scale analysis has been made of the fundamental atmospheric forecast equations in a coordinate system which allows topographic effects to be incorporated directly into the equations rather than into the boundary conditions. The equations furthermore are written in such a way that combinations of terms can be retained or omitted from the basic equations. The analysis has pointed up certain difficulties in the system that require further investigation.

A study has been made of iterative methods of obtaining the three-dimensional temperature structure of the atmosphere from satellite-borne measurements of atmospheric radiance (SIRS observations) which in the near future will have to be incorporated into routine weather prediction schemes.

A further activity was concerned with the specification and selection of powerful computing facilities by the South African

Weather Bureau. This led to the Weather Bureau ordering a powerful computer system with a dual telecommunication processor and an electrostatic off-line plotter. This system, supplemented by the computing facilities of the Institute, provides very attractive prospects of dynamical meteorological research, apart from the obvious great gains in operational competence.

### Theoretical aerodynamics

An advanced treatise on the mathematical principles of theoretical aerodynamics has been completed, thus concluding three years of study. On the practical side, a computer program was written for the National Institute for Defence Research (and implemented with the collaboration of that Institute) to calculate the stationary lift distribution on an aircraft wing.



### Differential equations

When a solid body moves in a viscous fluid, the spatial region occupied by the fluid changes with time, and the movements of the fluid and the body are coupled, due to drag. It is thus necessary to solve simultaneously for the velocity field of the fluid and the velocity of the body.

Two hypotheses were stipulated and it was shown that under suitable restrictions a so-called norm-bounded weak solution to the problem exists. The result has been published in a special report of the Institute.

### Numerically controlled machine tools

Activity in the field of numerically controlled machine tools declined owing to reduced demand from other CSIR institutes and the public sector. Nevertheless current developments are being followed. During February and March a course was again given on the industrial applications of numerically controlled machine tools and numerical control in general.

### Computer-aided design

The study of new developments in the field of computer-aided design continued. A report was compiled on the current activities at organizations involved in interactive cartographic work. This report led to a formal proposal for the establishment of a laboratory for computer-aided cartography.

### Data banks

A project on data banks was undertaken jointly by the CSIR and a manufacturer of data handling equipment. A wide-ranging study has been completed of existing efforts directed towards the storage and retrieval of geographically-based data. Following on this study, a start was made with the design of a generalized system suitable for operating on small to medium-sized computers.

### Computing centre

The computing centre recently became a separate division of the Institute with a mandate to operate the computing facilities, plan future computing services, provide limited programming assistance, implement and maintain an advisory service for users, and to undertake scientific investigations aimed at optimizing the services of the centre.

To cope with the continually increasing demand for computing services in the CSIR, the present system was expanded in December 1973. In spite of hardware and software enhancements, however, predictions of the growth in computing load indicate that the capacity of the present computing system will be exceeded during the second half of 1975, at the latest. Additional equipment will be installed by January 1975, but it is foreseen that during 1976 the computer will have to be replaced by a larger machine, or combined with a second central processing unit.

### Consulting services in numerical analysis

On various occasions the Numerical Analysis Division was asked by research workers in a number of different scientific and engineering fields to render advisory and programming services related to various areas of numerical analysis. In most cases straightforward applications of well-known methods and library programs made it possible to solve the problem, but in one instance actual case study research was necessary.

### Service programming

There has been a steady increase in requests for computer output in pictorial form: histograms, charts or graphs were produced by the line printer, and hundreds of graphs or diagrams by the plotters. This work included applications depicting economic trends; the cumulative distribution of different pollutants, and wind-roses, for air pollution studies; contours for hail distribution investigations and for mapping levels of aircraft noise disturbance.

Program development has continued on projects such as the study of eclipsing binary star systems, and investigations of air pollution, water reclamation, aircraft noise disturbance and agricultural performance. These programs have been run on a regular basis.

Other projects for which computer programs have been prepared include the distribution of the time intervals between the components of lightning flashes, a study of the radar reflectivity of rain and hail, and the design of a monument.

### Operations research

The major effort during the year was devoted to a study of the application of computer modelling techniques to town and regional planning. A program was developed for use by the



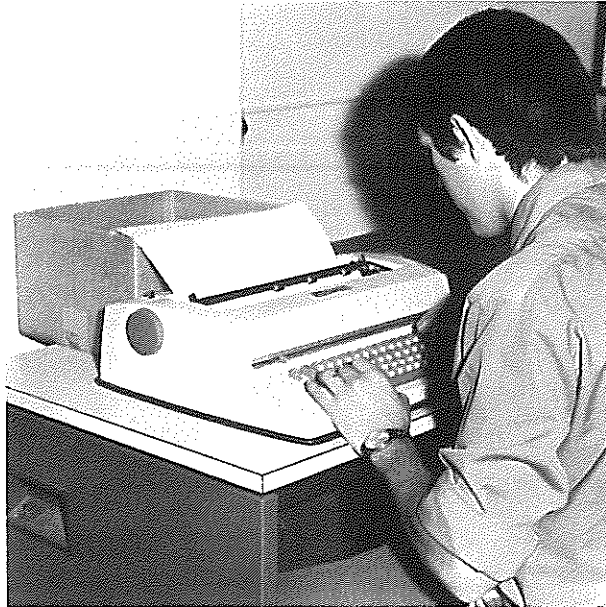
A high-speed computer terminal which permits remote entry and retrieval of batch jobs.

town planning division of the Department of Planning and the Environment for assessing alternative plans for the overall layout of the proposed development around Greater Saldanha Bay. This program was used in preparing proposals for the Cabinet.

### Statistical analysis of vitamin C supplementation

The Institute assisted research workers of the Medical Research Council in determining the optimum level of vitamin C to be added to the diet of mineworkers.

Blood samples were obtained from two groups of Bantu mineworkers whose diets were enriched by different quantities of vitamin C. The blood serum was analysed for vitamin C, in-



A typewriter terminal which permits interaction with a computer program during either its development or production stage.

#### **Statistical analysis applied to determination of diameter of wool fibres**

The diameter of wool fibres can be determined very accurately if a microscope is used, but the method is time-consuming. In contrast, so-called airflow measurements are less accurate but can be arrived at much more readily.

The NRIMS subjected to statistical analysis a series of results which had been obtained by the South African Wool and Textile Research Institute using eight sources of wool. It was found that the 'microscope value' of the fibre diameter can be deduced with reasonable accuracy from the 'airflow value'.

initially and again after one and two months of supplementation. A third group of mineworkers, to whose diet no additional vitamin C was added, was used as a control.

Statistical analysis of the results enabled an optimum level of supplementation to be decided upon.

#### **Statistical analysis of use of safety belts**

At the request of the Road Safety Council two safety belt surveys were mounted in the Pretoria area. The first survey was designed to determine the safety belt wearing rates (proportion of 'safety belt protected' drivers). The second survey was prompted by the fuel crisis; the object was to determine whether significant changes had taken place in the safety belt wearing habits of the public.

Statistical analysis of the results showed that the rates for the second survey were significantly lower than those found in the first survey.

#### **Statistical analysis of blood clotting characteristics**

The Institute assisted with the evaluation of research results obtained by a medical research worker at the H F Verwoerd Hospital in Pretoria who investigated the effect which a number of oral contraceptives had on the clotting characteristics of the blood of patients. The clotting characteristics were studied by observing what is known as the euglobulinolysis time (ELT) of the blood.

The Institute was responsible for the statistical analysis of the results, which were obtained with five different oral contraceptives administered to White and also Bantu patients, two further contraceptives being given to Bantu patients only.



# astronomy

## SOUTH AFRICAN ASTRONOMICAL OBSERVATORY

Director - SIR RICHARD VAN DER RIET WOOLLEY

The South African Astronomical Observatory (SAAO), which is operated by the CSIR in co-operation with the Science Research Council of Great Britain, has been established to conduct astrophysical research. The headquarters of the SAAO have been established in the grounds of the former Royal Observatory in Cape Town. The site for the observing station at Sutherland in the Karoo, at an elevation of 1 760 m, was selected on account of the favourable night sky for astronomical purposes, that is, for the number of fine nights per year, freedom from urban atmospheric pollution, absence of wind and freedom from atmospheric disturbances (the astronomers' 'bad seeing').

With the Phase I development programme at the Sutherland outstation complete the Observatory has put into operation research programmes making full use of the three telescopes which are now fully operational. The majority of these programmes involve massive amounts of observing and reduction time and will therefore not produce data in a form suitable for publication for some time. Nevertheless, it is important that observatories such as the SAAO, which have a substantial number of long-term staff, should undertake these programmes which cannot be tackled by university and other small departments.

### Photographic photometry

Much of modern astrophysical research is based on our knowledge of the magnitudes and colours of individual stars. The most accurate measurements of these parameters are currently made with photoelectric detectors and considerable time is devoted to such observations with the 100 cm and 50 cm reflectors at Sutherland. However, such instruments can measure only one star at a time and if information on many stars in a field is required a photographic technique must be used.

The two telescopes at present attached to the multiple refractor mounting are capable of taking, with the use of suitable filters, simultaneous wide angle (4 degrees square) pictures, usually in blue and yellow or blue and red broad band colours. The general technique for reduction of the data is to measure, with an iris photometer, the densities on the photographic plate of a sequence of stars of known magnitude together with those of the programme stars. Interpolation in the known sequence then provides the magnitudes of the programme stars. The photoelectric sequences have been set up by observers using the 50 cm telescope at Sutherland.

Current programmes concern the determination of the period-luminosity and colour-magnitude relationships of Cepheid

variable stars in the Galactic centre area and the Large Magellanic Cloud for comparison with theory and observations of similar stars in other associations.

### Detection of variable stars

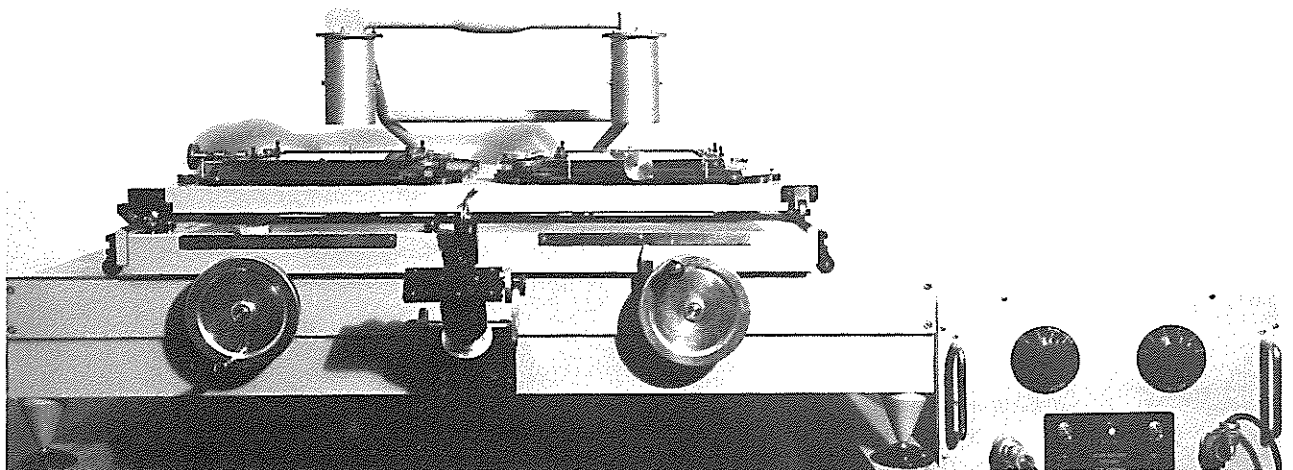
New variable stars are detected on photographic plates with the blink microscope. This equipment makes it possible to view plates of the same area, taken at different times, in the same eyepiece in quick succession. Stars of constant magnitude will appear stable but variables, which change their diameter with time, appear to 'blink' due to the change in diameter.

### Visitors

The inter-agency agreement between the CSIR and the Science Research Council makes provision for the use of the SAAO telescopes by visiting astronomers from the United Kingdom and South Africa. During 1974 observers from the Royal Greenwich Observatory, St Andrews University and University College, London were allocated about 30 per cent of the time on the Sutherland telescopes whilst the Royal Greenwich Observatory and Manchester and Oxford Universities made use of the 74-inch telescope in Pretoria.



A star field near the centre of our galaxy. (Sixty minute exposure in blue light with 20 cm  $f/10$  refractor.)



The blink microscope used for the detection of variable stars. Photographic plates of the same area, taken at different times, are viewed in the same eyepiece in quick succession. Stars of constant magnitude appear stable but variables, which change their diameter with time, appear to 'blink' due to the change in diameter.



Three other overseas visitors (from the RGO and Cambridge University) spent a considerable period at the SAAO whilst undertaking Ph.D. projects or personal research associated with the southern hemisphere.

The Department of Astronomy of the University of Cape Town has also undertaken programmes both at Pretoria and Sutherland.

#### 74-inch telescope

The 74-inch reflector which has been housed at the Radcliffe Observatory in Pretoria since 1938 was purchased by the CSIR and became the property of the SAAO on April 1, 1974.

It is intended to move the telescope to Sutherland as soon as possible and the new building is already under construction. It is hoped that the move will be complete and the telescope operational in the superior observing conditions at Sutherland during the second half of 1975.

#### Observing conditions at Sutherland

Records of observing conditions at Sutherland are now available for the first fully operational year (1973) and these have been published in an SAAO Circular.

These records show that the 1973 conditions were very much as predicted — about 50 per cent of the night-time hours having the excellent transparency required for high-grade photometry and a further 16 per cent being quite suitable for spectroscopy.

The accompanying graph which shows the number of photometric hours recorded each week illustrates that, as was expected, the usable time is fairly evenly distributed throughout the year as opposed to the weather patterns in the Cape Peninsula and the Transvaal. These figures indicate that Sutherland compares very favourably with most of the other major observatory sites — even the outstanding ones in Chile and Hawaii.

#### Infrared photometry

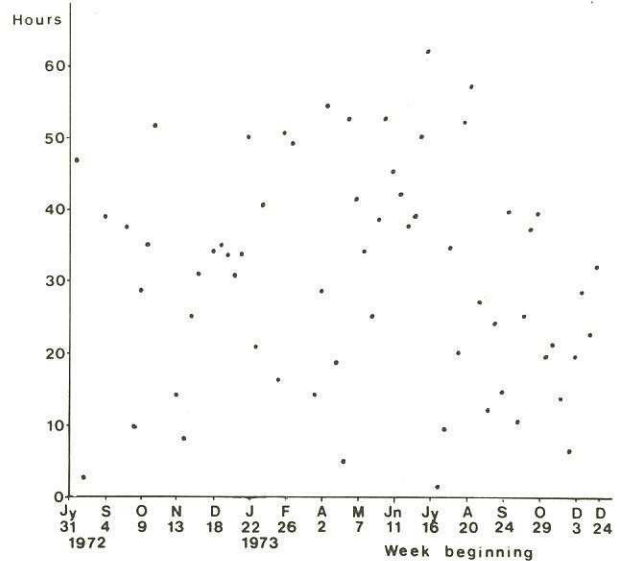
Over the past 10 years there has been an enormous increase in activity in infrared astronomy and many unexpected discoveries have been made. For instance some stars and galaxies radiate much more energy in the infrared than had been anticipated.

During the past two years an infrared photometer constructed at the Royal Greenwich Observatory has been used on telescopes at the Cape, Sutherland and Pretoria. Several significant contributions to infrared astronomy have resulted particularly in the 1,2 - 3,5  $\mu$  range. It was found that carbon-rich, hydrogen-poor variable stars are surrounded by clouds of soot (which emit in the infrared) whilst non-variable stars of the same composition do not have such clouds.

The globular cluster  $\omega$  Cen was shown to contain red giant stars which are considerably cooler than had been predicted. These stars are probably in a rapid state of evolution in which matter is ejected. Interesting results were obtained for various other objects, including possible optical identifications for cosmic X-ray sources, old novae, variable galaxies and objects connected with very early stages of star formation. A new infrared photometer is now being built at the SAAO so that this work can be continued and expanded.

#### Site development at Sutherland

The Phase II building programme now in progress at Sutherland makes provision for the new building to house the 74-inch telescope and the completion of the single quarters.



Observing conditions at Sutherland — 1972 August to 1973 December. The points indicate the number of photometric dark hours recorded each week.

To date, visiting observers have been accommodated in two two-bedroomed chalets and one of the houses originally built for technicians. The new facilities will provide a further six single bedrooms, a kitchen/dining complex and communal lounge and recreation areas.

Considerable progress has been made with the improvement of the site by the Superintendent and his staff in this difficult area. Grassed areas and gardens have been laid out around the houses and a large number of trees have been planted on the site.

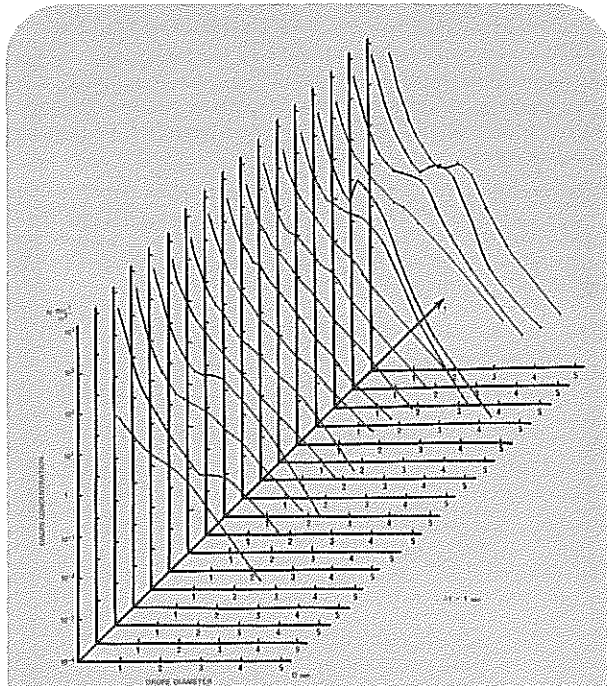
# telecommunications

## NATIONAL INSTITUTE FOR TELECOMMUNICATIONS RESEARCH

Director - R.W. VICE

The work of the National Institute for Telecommunications Research (NITR) embraces the study of natural phenomena and their effects on radio waves as well as the development of radio and radar systems for specialized applications.

The Institute and its research laboratories are situated at the University of the Witwatersrand in Johannesburg; the Radio Space Research Station (RSRS) is located at Hartbeesthoek, Transvaal, where the satellite tracking station of the Spaceflight Tracking and Data Network (STDN) is operated in terms of a contract between the United States' National Aeronautics and Space Administration and the CSIR.



The variation of drop size spectra throughout a rainstorm. An 8 mm Doppler radar is used to measure the motions of raindrops, from which the sizes of the drops can be derived. Significant departures from the generally assumed distribution of drop sizes have been found, and this has an important bearing on the relationship between the measured echo intensity and the rainfall measurement.

### Ionospheric research

The Institute carries out research into the ionosphere and its influence on the propagation of radio waves. Regular ionospheric observations are made near Johannesburg, at Hermanus, and on Marion Island. Observations of airglow are made near Pretoria and at Sutherland (on the site of the South African Astronomical Observatory). Bulletins of ionospheric data and predictions of the optimum frequencies for use in short-wave radio communications are issued monthly.

### Measuring rainfall by radar

Research into the use of radar to study clouds and precipitation is carried out at a radar experimental station at Houtkoppes, near Johannesburg. Here a radar system has been specially designed for the measurement of rain. It is being used to measure rainfall over a river catchment area as part of a hydrological experiment.

An 8 mm Doppler radar has been designed in order to measure the motions of raindrops, from which the sizes of the drops can be derived. Significant departures from the generally assumed distribution of drop sizes have been found, and this has an important bearing on the relationship between the measured echo intensity and the rainfall measurement. The power of the radar transmitter has been increased and a new signal processing system is being developed.

### Lightning research

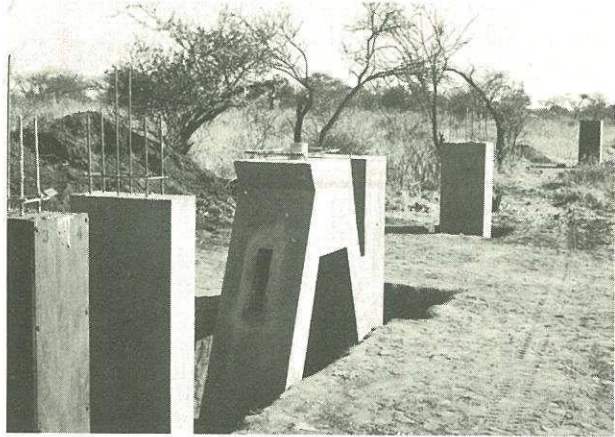
The Institute makes use of a system of spaced VHF receivers to obtain synchronized records of the radio noise radiated by lightning. From these records the development of the noise sources in space and time can be derived with great accuracy. These observations are supplemented by radar observations of precipitation in order to investigate the relation between the paths of lightning discharges and the precipitation. Additional radar equipment is being built and will be used in an attempt to observe echoes from lightning channels in the C and X bands.



### Distance measurement

An important aspect of the Institute's work is the development of electromagnetic systems for the measurement of distance. As a result of continued research and development since the invention of the 'Tellurometer' system of distance measurement in 1955, South Africa has maintained its lead in the production of such equipment.

Because of the increasing accuracy of distance measuring equipment the need has arisen for a standard against which this can be calibrated. The Institute, with the co-operation of the Director General of Surveys, is now erecting a standard base to the north of Pretoria. When the concrete pillars of the base have been built they will be allowed to settle for about a year before the standard line is measured. The line, which is defined by stable underground markers, will be approximately 864 m long, and will be accurate to within a few parts in  $10^7$ .



Concrete marker pillars for a standard base to be used for calibrating distance measuring equipment. These pillars will be allowed to settle for about a year before the standard line is measured. The line will be accurate to within a few parts in  $10^7$ .

### Space research

The Institute operates the Radio Space Research Station at Hartebeesthoek on behalf of the United States' National Aeronautics and Space Administration (NASA). Originally this comprised two tracking stations, the Deep Space Instrumentation Facility (DSIF) and a station of the Spaceflight Tracking and Data Network (STDN); the DSIF, however, ceased operation at the end of June, 1974.

The STDN station is one of the world-wide network of stations established by NASA to track and communicate with scientific earth satellites. It is expected that this station will close towards the end of 1975. The tracking activity, however, is being maintained at a high level.

In terms of an agreement concluded last year between the CSIR and the French Centre National d'Etudes Spatiales (CNES), the Institute took over full responsibility for the operation of the French satellite tracking station near Pretoria on 1st April, 1974.

'TELEMAQUE', the main telemetry and command antenna of the French Tracking Station at Paardefontein, north of Pretoria, recently underwent a major overhaul. The photograph shows the remounting of the steerable array of yagis which track European, American and Canadian satellites. In April 1974 the CSIR took over the management and running of the French Tracking Station on behalf of the Centre National d'Etudes Spatiales.

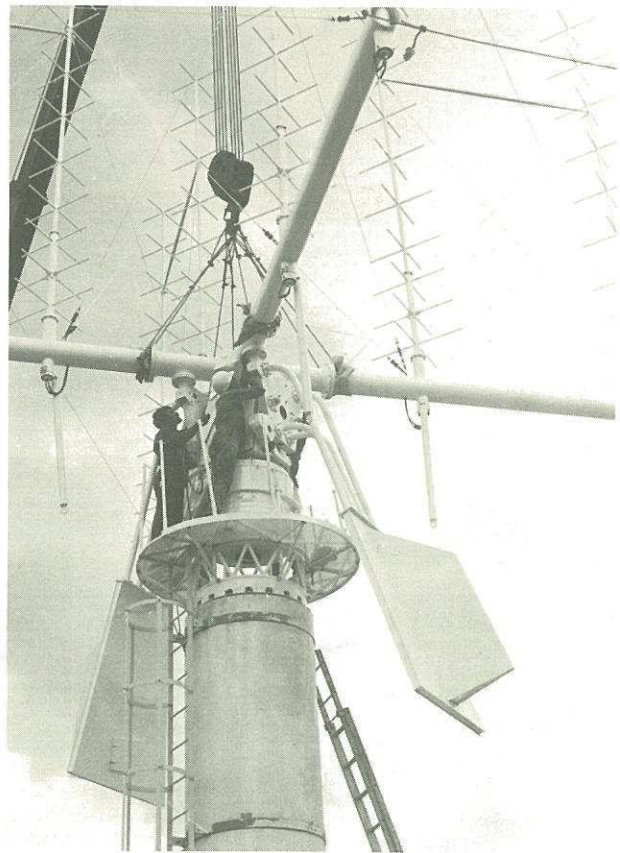
### Radio astronomy

The Institute has since 1963 carried out a programme of radio astronomy at the Radio Space Research Station at Hartebeesthoek, making use of a 26 m parabolic antenna at the DSIF when this was not required for deep space tracking. The necessary ancillary equipment was designed and built by the Institute. There are two radiometers, operating at 2 295 and 4 200 MHz.

The main continuing programme over the past seven years has been the study of variable radio sources. This work was unavoidably disrupted by the closure of the deep space tracking station, but observations were made up to the time of closure and will be resumed as soon as possible.

Other programmes have been the observations using intercontinental interferometers with base lines extending from South Africa to Australia, Europe and North America, and a survey at 2 295 MHz of radio sources in the southern sky.

Now that observations are no longer confined to periods between deep space tracking operations, it will be possible to expand the programme considerably, and funds have been made available for this purpose.



# road research

## NATIONAL INSTITUTE FOR ROAD RESEARCH

Director - DR S H KÜHN

Road and traffic authorities encounter a wide range of problems in their endeavours to ensure the most economic use of roads as a public amenity. The research programme of the National Institute for Road Research (NIRR) is directed at finding solutions to these problems through research into the planning, design, construction, maintenance and operation of roads and road systems, into road safety and the behaviour of road users, and into the role of roads and road transport in society. Another important function of the NIRR is to ensure the effective dissemination and application of research findings throughout the road industry.

The NIRR works in close collaboration with national and provincial road authorities, the South West Africa Administration, the South African Railways, the National Road Safety Council and the road industry, which together provide most of the funds for road research. The Rhodesian Ministry of Roads and Road Traffic is also affiliated to the Institute and makes an annual contribution to research costs.

### Improved road tars and saving of oil

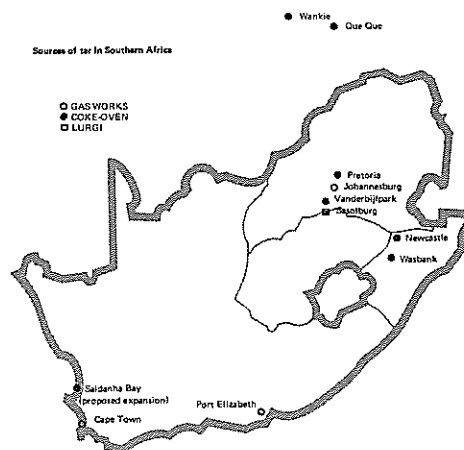
Recent international developments have affected the supply of oil and its cost and these two factors will undoubtedly have an effect upon the South African road industry.

An important aspect which must not be overlooked is whether bitumen, which is derived from oil and is used extensively for road construction and maintenance purposes, will continue to be available. (In the past bitumen has always been preferred to coal-tar even though the latter, which is a by-product of the local steel industry, was available.) The Institute began to investigate, even prior to the Middle East conflict, the probable future availability of bitumen and concluded that, while the supply position could not be forecast, the cost of this important material was certain to increase sharply.

Another important consideration was that, in view of the expansion of the steel industry, the amount of coke-oven tar produced in South Africa would increase considerably and by the end of the decade there would probably be sufficient locally-produced coal-tar to satisfy the country's requirements for road binders.

For a number of years the Institute has conducted research in several areas in which coal-tar could be used to replace bitumen. The situation to date is as follows:

- The development of low-volatile PVC tars for surface treatment maintenance has reached the stage at which a



minimum service life of five years can be expected and, depending on the performance of existing surfacings, this figure may well be increased. It has been suggested that one of the reasons coke-oven tars do not perform well in surfacings in South Africa is that they are oxidized in the severe weathering conditions that prevail on the Highveld. However, studies of the change in composition of tars and PVC/tars in service, using gas chromatography, show that





Rumble surfaces alert drivers at the approach to an intersection. They are used in conjunction with warning road signs and markings where these have proved ineffective on their own. Correctly spaced rumble surfaces guide the driver into a suitable rate of deceleration. This is particularly useful under conditions of poor visibility and on slippery roads.

there is a strong correlation between the hardening of tars in service and the evaporation of the lighter tar oils. This indicates that the durability of tar can be improved if the composition of the tar is changed to include fewer of these oil fractions.

- Tar derived from the Sasol (oil-from-coal) process is being evaluated for use in surfacings.
- Tar is a suitable hot-mix binder for use in the construction of the base of a road. It has been estimated that savings of more than 35 per cent in material costs and 15 per cent in the overall construction costs are possible. These savings may be even greater because of the recent increase in the price of bitumen. The effect of mixing conditions upon the change in composition and viscosity has been examined. Specifications for a tar which shows a minimum hardening during the preparation of hot mixtures have been prepared.

#### Motor vehicle safety belts

Following a request by the Advisory Committee of the National Road Safety Council, the Institute undertook a literature survey on the efficacy of safety belts as a life-saving and injury-reducing factor in road accidents.

The subsequent report described the different types of safety belts, their function and correct usage as well as certain objections to belt usage. The advantages of using belts are evident

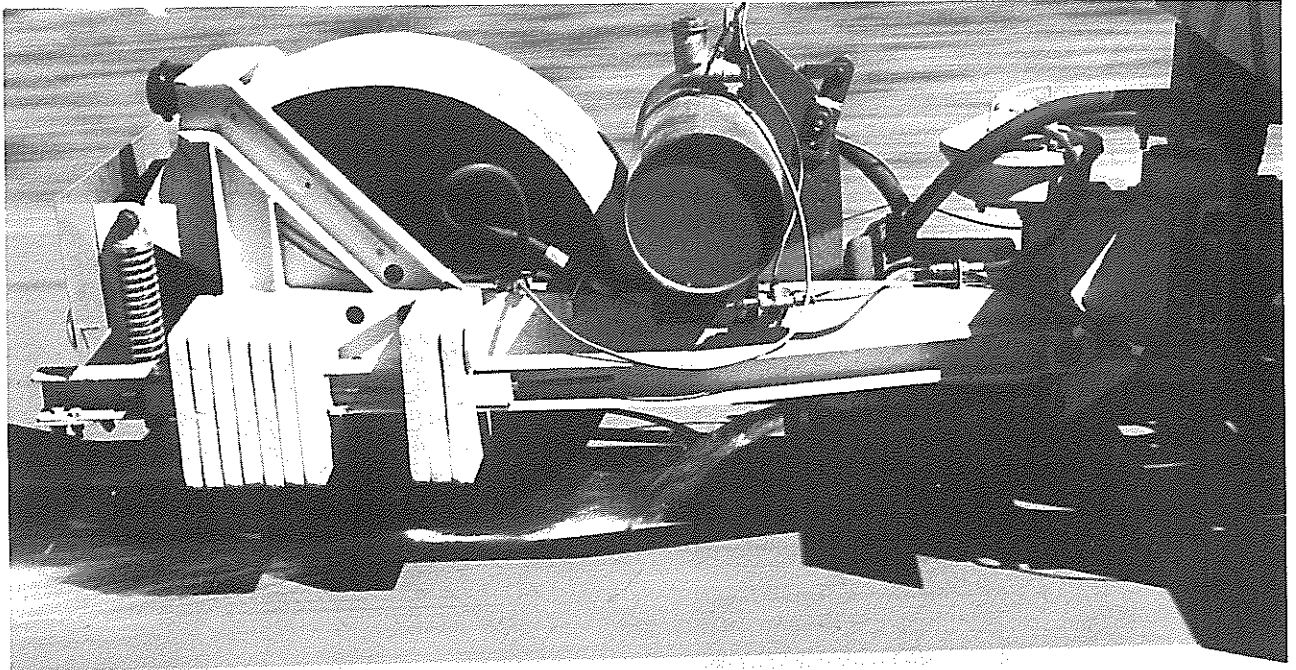
and the indications at present are that the combined lap-and-shoulder belt is the most efficient constraint system which can be employed to reduce the injuries sustained by vehicle occupants in accidents.

The National Road Safety Council subsequently requested the Institute to evaluate these data, and to make recommendations regarding the use of safety belts in motor vehicles in South Africa. Various aspects were considered, such as age limit for front seat occupants and incentives likely to increase the use of belts. Amended draft legislation was proposed and certain suggestions regarding publicity and law enforcement were made.

In a separate report it is stated how data on casualties in various types of vehicles were obtained and used to estimate the likely influence of increased safety belt use on road accident fatalities in the Republic of South Africa. Assuming the use of safety belts by 70 per cent of all motor car occupants, and a reduction of 30 per cent in fatalities as a result of seat belt use, it was estimated that, in 1971, fatalities amongst front seat occupants of motor cars could have been reduced by 275; this is 3,3 per cent of all fatalities for all categories of accidents. Cost-benefit calculations show that if belts are used the costs can be fully justified.

Another sample survey was designed and implemented to estimate the proportion of drivers of motor cars wearing 3-point safety belts in Pretoria and the surrounding rural areas during





The brake-force trailer, developed by the NIRR, which measures skid-resistance of roads. Tests carried out with the trailer have shown that an open-graded asphalt overlay increased skid-resistance, over the speed range of 25 to 100 km/h, by about 0,2 units thus decreasing the calculated stopping distance, from 100 km/h, by 40 per cent.

daylight hours. On ordinary rural roads carrying at least 800 vehicles per day this was found to be 5,5 per cent, on rural freeways 10,3 per cent, and in the Pretoria urban area it was 3,2 per cent in this particular survey. Further surveys are being planned.

#### Properties of open-graded asphalt overlay

The open-graded asphalt overlay laid on a portion of the Ben Schoeman Highway between Pretoria and Johannesburg to improve skid resistance has been under observation by the NIRR. It has been noted that as far as skid-resistance, spray throw-up, riding quality and noise are concerned, this overlay undoubtedly benefits the road user.

Tests carried out with the NIRR brake-force trailer have shown that the overlay increased the skid-resistance, over the speed range of 25 to 100 km/h, by about 0,2 units thus decreasing the calculated stopping distance, from 100 km/h, by 40 per cent. The wet-weather accident rate (expressed as a percentage of total accidents) decreased to 7 per cent during the first year with the new overlay compared with 28 per cent during the previous year.

The open-textured nature of the surfacing causes a significant decrease in the amount of spray thrown up by fast-moving vehicles, thus reducing the safety hazard caused by poor visibility.

The overlay has improved the riding quality but some motorists still complain of experiencing vibrations when driving within a certain speed range on the Highway. However, an investigation indicated that the vibrations were caused by imperfections in the vehicles and not by any defect in the road surface.

The noise generated by the interaction of vehicle tyres and the road surface is heard both within vehicles and by persons living and working near the road. An investigation has been carried out to compare the noise generated by open-graded asphalt

with that generated by other types of surfacing. As far as the noise inside a vehicle is concerned, the type of surfacing has no effect at high speeds because of the overriding effect of wind noise. At a speed of 70 km/h, however, the noise level inside a typical passenger car was 64 dB(A) on the open-graded asphalt compared with 73 dB(A) on a surface treatment, which is a significant improvement. Normal speech is made easier against a lower background noise and it is also possible that lower noise levels will cause less driver fatigue on a long journey.

The noise measured outside the vehicle under standard conditions was about 6 dB(A) lower on open-graded asphalt than on surface treatment. This means that at normal traffic speeds, for an equivalent energy noise level, open-graded asphalt could take about three times as much traffic as surface treatment. Noise pollution of the environment is not a problem for most rural roads, but it is a problem in towns, particularly where freeways pass through residential areas. It is possible, therefore, that open-graded asphalt will provide the optimum wearing course for urban freeways because of its good skid-resistance and anti-splash properties combined with low noise generation.

#### Rumble devices for road safety

Rumble devices alert the unwary driver to the need for caution on the approaches to road hazards such as unexpected sharp curves, outlying circles, isolated stop intersections and unguarded railway level crossings. They are constructed by placing a surfacing containing 13 mm or 19 mm size stone on the existing roadway to form intermittent rumble surfaces or rumble strips. They are used in conjunction with warning road signs and markings where these have proved ineffective on their own. If the driver heeds the message of the road signs and slows down, his tyres set up a reassuring rhythmic rumble as his vehicle crosses the intermittent surfaces of coarser stone on the roadway. Should he fail to slow down, the beat becomes quicker and imparts a sense of urgency to which he quickly responds by braking. Correctly spaced rumble surfaces guide



the driver to a suitable rate of deceleration. This is particularly useful under conditions of poor visibility and on slippery roads.

At the request of the National Road Safety Council the NIRR investigated the use of rumble devices both overseas and locally. Rumble installations in the United States have reduced accidents at isolated intersections by about 40 per cent through reduced speeds and improved stop observance. In South Africa a number of rumble installations have been constructed on rural roads. Although no local accident data are available, provincial roads engineers consider them of value in alerting drivers to the need for caution on the approaches to hazardous curves or intersections.

The NIRR has drawn up guidelines covering the investigation of the site, selection of the rumble device, and construction of the rumble installation. An effective layout pattern for intermittent rumble surfaces has been developed.

### Alcohol and road safety

Much attention has recently been given to the effect of alcohol consumption on motor vehicle driving. The National Road Safety Council requested the Institute to prepare a case for reducing the legal blood-alcohol level for drivers in the Republic from 0,15 per cent to 0,08 per cent. Local and overseas sources of information were consulted before drafting this motivation.

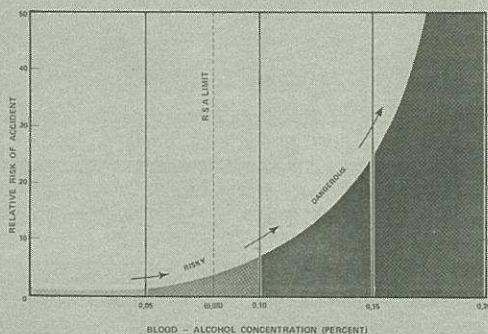
A report was then written. It described the effect of alcohol on the human brain and consequently on a driver. His abilities are impaired by alcohol, especially as regards his reaction time, judgement, performance, perception and risk of exposure to accident. The application of legislation in the Republic of South Africa and countries abroad was examined and it was shown that those countries that have adopted stringent legislation, coupled with adequate enforcement of the law in this regard, have obtained excellent results in combating the problem. From this study of law enforcement practices and court procedures in regard to alcohol and traffic, including the role of the police, blood and breath tests, and medical evidence, it appeared that, in the search for effective countermeasures, most problems are encountered in law enforcement.

Following the announcement that the new legal blood-alcohol limit of 0,08 per cent would become effective from 1 October 1973 random breath-tests were carried out on 730 drivers in Pretoria and the surrounding rural area between the hours of 17h30 and 01h00. This was the preliminary of a 'before and after' study to determine the effect of the new legislation on drivers. It is interesting to note that the 'before' survey revealed

that 23 per cent of the drivers tested had consumed alcohol prior to driving.

Procedures for enforcing the new legislation are clumsy and inconvenient at present to both drivers and police. The Institute has therefore begun to explore the possibility of streamlining present methods and procedures for measuring the alcohol content of blood. Tests have been carried out to compare and assess the convenience and accuracy of two breath-alcohol screening devices for use by police in deciding whether a driver should be arrested and taken to the district surgeon for blood tests. At the same time, two other breath-testing instruments have been studied which could at a future date replace blood tests entirely and provide substantive evidence of blood-alcohol contents for use in court.

**Driving after drinking:** As the driver's blood-alcohol concentration increases the risk of having an accident increases sharply.



# water research

## NATIONAL INSTITUTE FOR WATER RESEARCH

Director - DR G G CILLIE

Water research is vital in a country like South Africa with its relatively scarce sources of water. The National Institute for Water Research (NIWR) therefore strives to develop expertise on the efficient use and conservation of available resources. Its activities include, inter alia, investigation of the purification of water prior to use, the treatment of water after use to meet specific standards, and the investigation of specific types of pollution in dams, rivers, estuaries and even the sea. The Institute has a total personnel of 209 and is divided into a number of

research groups and regional laboratories. While the regional laboratories at Durban, Bellville, Bloemfontein and Windhoek concentrate on local water problems, research groups in Pretoria undertake basic and applied research on a broad spectrum of problems concerning the optimum utilization of water. Research groups have been established for freshwater biology, water quality, biological treatment processes, physico-chemical treatment processes and desalination. There is also a group which deals with technical enquiries.

### National marine monitoring programme

This investigation, sponsored by the Department of Planning and the Environment, recently began with, among other things, the examination of the input of wastes into the sea between Durban and Umbogintwini. It is concerned with impact area studies to locate major sources of pollution, coastal reference surveys to establish background reference parameters and the extent of pollution effects, open sea reference parameters and data handling.

The impact area studies cover a 30 km stretch of coast from Durban southwards in which all canals, rivers and effluents have been sampled and accumulator species collected and analysed. A number of canals and some of the effluents contribute to mild organic pollution of the sea.

Information from studies conducted in Natal prior to the present programme gave background information on parts of the Natal coast and indicated the sporadic presence of some heavy metals and chlorinated pesticides in animal tissues and sediments. Low levels of DDT, DDD and lindane are widespread in some marine organisms and sediments on the continental shelf.

An ocean reference transect survey has been initiated off the east coast to evaluate present conditions on a seasonal basis and to determine existing levels and variations of recognised pollutants.

The transect consists of a line of stations at right angles to the coastline off Cooper Light. Sampling stations are situated 2 km

apart for the first 10 km and thereafter at 25, 50, 75 and 100 km off-shore. The outermost station has a water depth of approximately 2 900 metres. The first 10 km are being subjected to more intense scrutiny since the variations in the majority of the measurements will probably be greatest in this region with a trend towards greater uniformity off-shore.

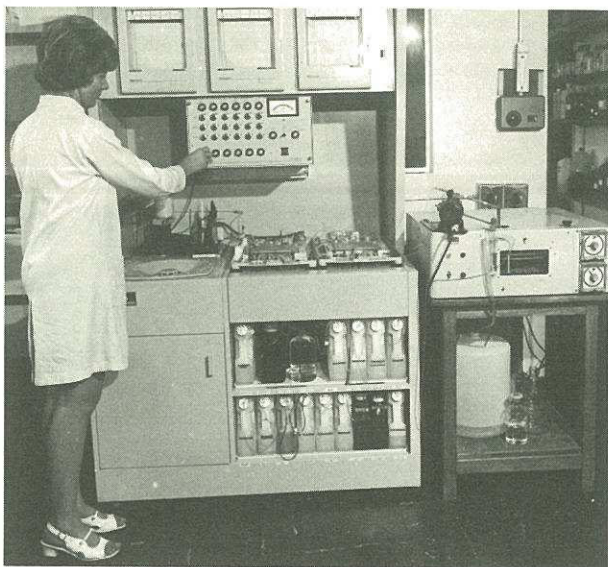
The first sampling run of the transect was undertaken by the RV Meiring Naudé between 11 and 13 March 1974. The sediment and water samples collected were analysed for dissolved oxygen, organic matter, heavy metals, oil and chlorinated hydrocarbons. Current characteristics, temperature and salinity were recorded simultaneously, and samples for nutrient analysis taken at standard depths at all the stations.

### Disposal of mineralized industrial effluents by irrigation

As a corollary to the successful plot experiments carried out at Springs with irrigation of highly mineralized effluents from a pulp and paper factory, the NIWR has since 1968 been conducting lysimeter experiments at Pretoria to determine the long-term effects of this irrigation on lucerne yields and soil condition.

At the end of the previous growth season a reduction in the yield of lucerne was observed, but the latest information indicates an actual increase in yield of 1,17 g to 1,45 g (dry mass) per year. This increased yield might have been due to a good rainy season, a reduction in the calculated sodium content of the soil, or a reduction in the amount of sodium applied.





The CSM6 AutoAnalyzer used in the automatic analysis of industrial and potable waters.

Promising results were obtained in laboratory studies and the system has now been installed at Windhoek, with the support of both the Water Research Commission and the Municipality of Windhoek, to monitor continuously both the quality of potable and reclaimed water. The system incorporates an alarm that could be set off if a toxic substance were present at a concentration exceeding a certain predetermined value. Such an alarm situation would then be followed by a complete chemical and microbiological analysis to ascertain the reason for the alarm.

The system, as applied at Windhoek, also makes provision for long-term evaluations to determine if sub-lethal concentrations of toxicants are present. Fish are subjected to a pathological examination at selected intervals to determine if any changes in the tissue have taken place. These studies are supplemented with a thorough chemical and microbiological evaluation of the quality of the water. If the system functions well at Windhoek, it will be extended to other applications in the Republic of South Africa.

Pilot scale continuous ion exchange plant for the treatment of industrial effluents.

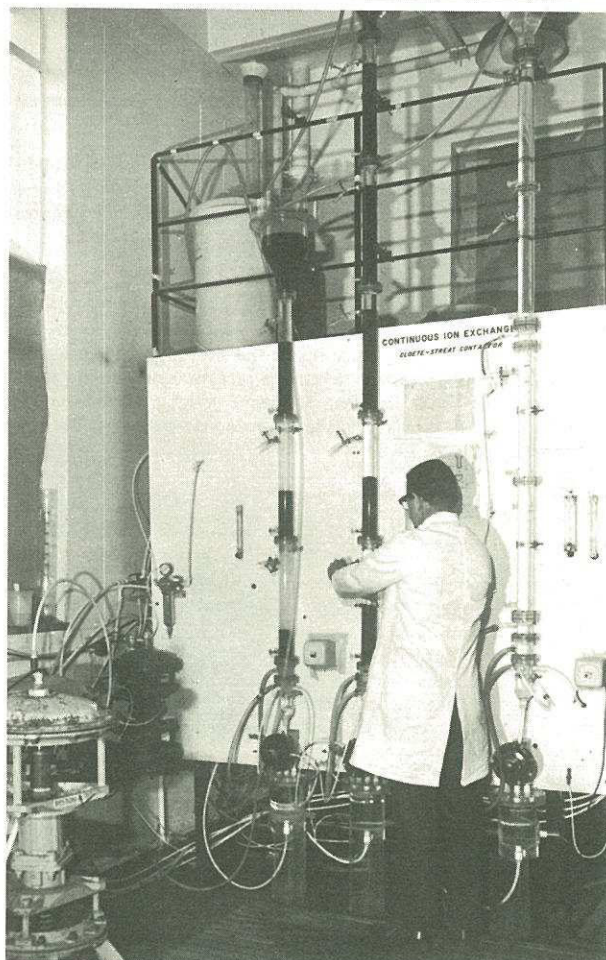
An inspection of the irrigation plots at the factory indicated that soil previously regarded as irrevocably damaged could be revived by a small addition of lime, gypsum and artificial fertiliser and that lucerne production was not hampered in spite of the fact that irrigation with a water rich in sodium was continued.

It is concluded that under carefully planned and executed conditions, lucerne can be grown on soil irrigated with an effluent containing from 20 to 30 milli-equivalents sodium per litre. It also applies to a soil in bad condition after treatment with lime and gypsum.

#### Use of fish to measure water quality

It has been accepted practice for a long time to make use of animals to evaluate the possible toxic effects of newly developed medicines to man. Laboratory animals are used, for example, to evaluate the possible dangers of smoke, fog and toxic substances in water. Fish are generally used to measure or indicate the presence of toxic constituents in water, particularly where industries discharge heavy metals into the environment.

The National Institute for Water Research has now developed a simple and reliable system that can be applied with the minimum of supervision to measure the quality of both potable and reclaimed water. The system, which has been developed in conjunction with the Division of Electronic Instrumentation of the National Electrical Engineering Research Institute, is based on the fact that the respiration rate of fish in an aquarium can be electronically measured without interfering with the ability of the fish to swim. Other systems, used by researchers in other parts of the world, have normally made use of electrodes that had to be attached to the fish, thus seriously hampering their activity.





### Study of infectious hepatitis virus in water

An affinity chromatographic method for the isolation and purification of the hepatitis B associated antigen from faeces, urine, sewage or water has been developed. This method may prove of vital importance in the isolation of the hepatitis A virus or a hepatitis B associated antigen. It consists of coupling antibodies directed against a certain antigen to agarose in a chromatographic column. When the relevant antigen is passed through the column, it is selectively trapped by the antibodies and may be released afterwards. The serum of convalescent hepatitis A patients contains high concentrations of antibodies directed against the virus. Columns charged with these antibodies could thus serve to isolate the virus from faeces or contaminated water.

A study of the incidence and behaviour of hepatitis B antigen (HB Ag) in faeces, urine and sewage has been completed. The antigen was not detected in sewage or faeces and urine of 23 patients with HB Ag antigenaemia by the above method combined with radio-immuno-assay. The absence of HB Ag from faeces is apparently due to enzyme-like antagonists which destroy the antigen. A similar substance was produced by three *Pseudomonas* species, but not by a wide range of other bacteria. The antagonists have been purified and concentrated, and could prove useful as HB Ag decontaminating agents. Sewage does not contain sufficient quantities of the antagonists to affect the stability of HB Ag. The absence of HB Ag in sewage indicates that sewage plays a negligible role in the spread of HB Ag and viral hepatitis type B.

Electron microscopic studies on affinity chromatography preparations from faeces of hepatitis A patients have been continued. The morphology of particles in these preparations resembles that of a hepatitis A associated agent recently isolated overseas and in some respects that of polio virus.

The use of marmoset monkeys as laboratory animals in research on hepatitis A has been investigated. It was possible to cause hepatitis in one of the two available animals by injection with a faecal preparation of a hepatitis A patient.

No cytopathogenic or other morphological changes were detected by light or electron microscopy in a hepatoma cell line inoculated with serum containing HB Ag or a faecal preparation of a hepatitis A patient.

### Diatom taxonomy

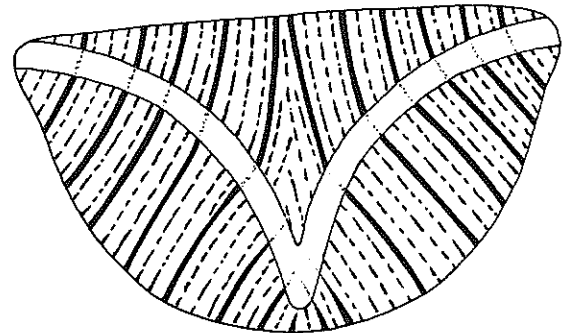
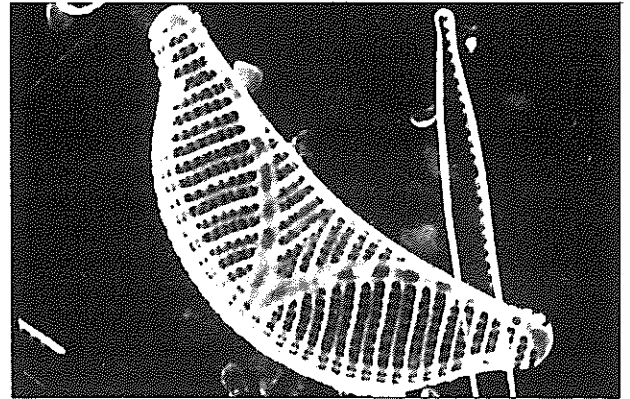
Diatoms are classified according to the intricate patterning of their siliceous frustules. In life, organic mucus covers these shells. Acid treatment is therefore used so that their patterns may be studied. The frustules are mounted on glass microscope slides and observed under the light microscope, the maximum theoretical magnification of which is 2 000 diameters. This instrument, furthermore, has a limited vertical depth of field, so that the focus has to be altered from the surface of the diatom to its sides in order to visualize it.

Light microscope photography is therefore of limited success as little detail can be obtained. Diatom taxonomists used to reproduce specimens by means of line drawings which required both skill and hours of tedious and tiring microscopic observation. The result was a two-dimensional drawing of major patterns only. Diatom taxonomy is very difficult as subtle differences are not apparent with such techniques.

The scanning electron microscope (SEM) provides the solution to the diatomists' problems. Removal of mucus is as for light microscopy. A drop of diatom suspension is thereafter dried on an aluminium specimen peg and coated with a heavy metal — a procedure taking approximately one hour. Specimens are then viewed immediately.

Because of the great depth of field obtainable with the SEM, objects can be viewed in three-dimensional relief at

magnifications of up to 50 000 diameters. Polaroid photographs of such specimens are directly available for comparison. So much detail is shown so rapidly and without tedious drawing that the SEM is revolutionizing these taxonomic studies.



### *Epithemia sorex* Kützing

Top: Photograph using scanning electron microscope. The scanning electron microscope enables the diatom taxonomist to view specimens in three-dimensional relief at magnifications of up to 50 000 diameters. Bottom: Line drawing using light microscope.

Launching a boat into an estuary on the Natal coast for estuarine pollution studies.





# electrical engineering

## NATIONAL ELECTRICAL ENGINEERING RESEARCH INSTITUTE

Director - J D N VAN WYK

**The National Electrical Engineering Research Institute (NEERI) is concerned with light-current and heavy-current research in the field of electrical engineering. The Institute consists of divisions for applied electronics, automation, electronic instrumentation, power electrical engineering, signal processing, solid-state electronics, and training and information. Work is done in such diverse fields as computer technology, process control, the application of digital techniques to data processing, information theory and signal processing, medical electronics, thin-film and semiconductor technology and its applications to electronic circuit systems and microminiaturization, and the investigation of problems peculiar to the Republic in heavy-current applications.**

### Lightning parameters

Although a good deal of information on lightning in Europe is available, such as the distribution of currents and their waveforms, it was decided some two years ago to start a measurement programme at the CSIR with the aim of determining typical values of such parameters under South African conditions.

A 60-metre insulated mast, situated on a koppie on the CSIR site in Pretoria, is the main feature of the recording system. During the time it has been in operation, which is a little more than one lightning season, the mast has been struck twelve times, and current measurements were obtained from eight of the lightning strokes.

To obtain data which relate the striking distance to intensity of lightning current, photographic techniques are being applied which enable the geometry of flashes to the mast to be studied. Only one observation was recorded during the past season, but the effective striking distance of about 300 metres, as measured, seems to be significantly greater than that calculated by means of currently accepted theories, and may support the theory proposed by a NEERI research worker.

This result, if substantiated by further observations, can be of fundamental importance in the planning of lightning protective measures and in the assessment of the lightning performance of transmission systems.

### Country-wide installation of lightning counters

For some years now, the Institute has collaborated with a working group of CIGRE (International Conference on Large Electric Systems) in the development and testing of lightning flash counters. These are instruments for determining the number of ground flashes per unit area during a lightning season. A

knowledge of the ground flash density, as it is called, is important when protective measures against lightning are to be planned or improved for power and communication systems.

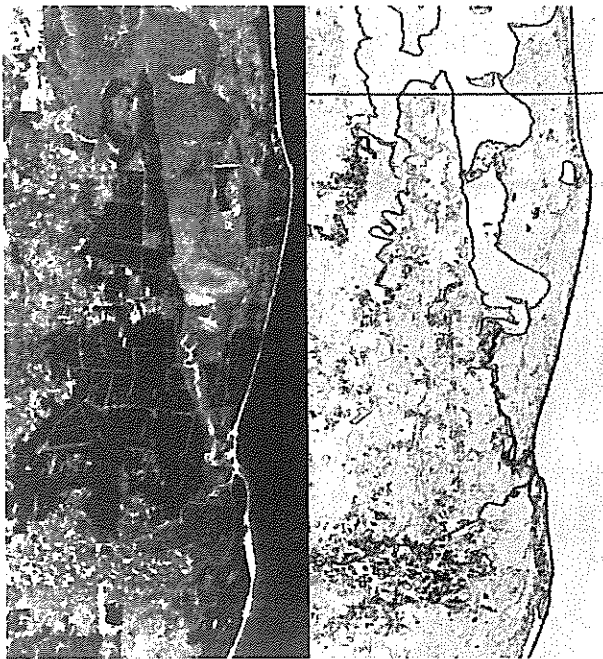
The two most important parameters which had to be determined were the effective range of a counter and its correction factor, i.e. the proportion of total registrations of a counter which are due to ground flashes.

In the determination of these parameters for different types of counters, a locally developed type known as the RSA 10 offered very clear advantages. The Co-ordinating Committee for High Voltage Research and Testing Facilities has recommended that this counter should be distributed within the Republic and South West Africa for the purpose of compiling a ground flash density map. Funds have been contributed by various organizations, and negotiations are under way with a view to having four hundred of these counters manufactured locally. It is considered that a reasonable coverage of the Republic and South West Africa will be achieved by this number of counters, and the intention is to record over a period of about ten years.

### Picture processing

The Signal Processing Division has added a facsimile receiver transmitter to the peripheral equipment of its time series analyser with fast Fourier processor in order to extend the facility for processing pictures.

Although the term picture processing can cover a very wide field, from optical techniques to automatic pattern recognition by computer, applications were limited mainly to contrast enhancement. Picture processing by computer is best suited to those applications where the primary source of picture information is an electrical signal obtained by a scanning system such as is used, for example, in satellites or in a scanning electron



Examples of picture processing by computer. These satellite photographs (ERTS-photographs) have been processed to enhance certain features.

microscope (SEM). Where the primary source is a high-quality photograph, detail can be lost or extra noise introduced by the scanning system. However, computer techniques can be used effectively for X-ray picture enhancement.

Practical picture processing applications so far have included contrast enhancement of SEM photographs and processing of ERTS photographs.

#### Simulation of Grootfontein aquifer

The study of the flow dynamics of the Grootfontein aquifer by means of simulation on a hybrid computer was begun in 1970. To test the feasibility of the method, a preliminary model was constructed on the basis of data supplied by the Department of Water Affairs. Once the method had proved itself, the Hydrological Research Institute of the Department agreed to second to this Institute a member of staff who will be concerned with data verification and the hydrological interpretation of computer results.

A very extensive simulation was completed recently, and has been received favourably by the Department of Water Affairs. The model has been used to study the change in water reserves in the aquifer when irrigation pumpage at various points in the aquifer is permitted to increase by controlled amounts. Work in co-operation with the Hydrological Research Institute is continuing.

#### Sugar factory automation

The Institute has been requested to construct a mathematical model of a raw sugar factory, and the work is being done in collaboration with a sugar company and with assistance from

the Sugar Milling Research Institute. Up to the present a model of the milling train has been constructed and used to deduce a strategy to control the water flow to the various mill sections.

Work on the processing end of the factory is in progress and is being carried out by a member of staff of the CSIR's Chemical Engineering Research Group who has been seconded to the Institute.

#### Modelling of a rotary drum filter

The Institute is carrying out an investigation in co-operation with a gold mining company in order to find the conditions for minimum dissolved gold losses. When these conditions are known, initially one filter will be automatically controlled, and finally the whole filter plant. A member of staff of the Institute collaborated with the company in preliminary work to determine the efficiency of rotary drum filters. The company concerned then decided to continue with the investigation to a greater technical depth and took steps to prepare an operational filter in a gold mine for a series of experiments.

The Institute has contributed to the project by planning experiments, providing a data collection system, and analysing experimental results; also by giving advice on the instrumentation requirements.

#### Instrumentation service in Western Cape

The Electronic Instrumentation Division is a service division which is responsible for developing and constructing electronic instruments when suitable equipment is not available commercially; for providing maintenance where necessary for electronic equipment in use in the Institutes of the CSIR; and for running a calibration centre for electronic instruments.

A long-standing request for similar services to be available in the Western Cape has now been met by establishing a group of the Division in Bellville. This group will cater for CSIR Institutes, the Medical Research Council, the universities and industry in the Western Cape.

#### Small-scale automation

In co-operation with the Technical Services Department and the Timber Research Unit of the CSIR, the Institute is investigating means of automatically measuring the production of a timber sawmill. This is the first project undertaken under the auspices of the newly established Automation and Production Technology Service (APTS) of the CSIR.

The output from the various production lines of a sawmill is to be recorded in terms of total length of timber according to the standard sizes (six widths and three thicknesses). Production quantities are displayed on 18 counters arranged in a 6 x 3 format.

To test sera and medicants at the South African Bureau of Standards, these substances are injected into rabbits whose body temperatures are measured throughout the day according to a prescribed time schedule. At the end of the day various calculations are carried out.

To automate this routine testing procedure, the Institute designed a suitable computer-operated data acquisition and processing system and also prepared the necessary programs. These control all the measurement steps necessary and provide a neat printout of the final results.

#### Information services

The information group circulates about 160 electrical engineering journals amongst 82 members of staff of the Institute in accordance with an interest profile which is updated yearly.



Another important service provided by the group is the advice given to intending purchasers of new electronic equipment.

The group is also assisting the CSIR's Information and Research Services in introducing a computerized service for the selective dissemination of information about articles in electrical engineering journals. Magnetic tapes from INSPEC (Information Service of the Electrical and Electronics Engineers of America) containing abstracts of articles from all the important journals are compared by a computer with the interest profile of an engineer, and a printout of the appropriate abstracts is made on cards and sent to him.

#### Training of electronics technicians.

The Institute is responsible for conducting a training scheme for electronics technicians for the CSIR. This scheme involves alternate sessions of full-time theoretical classes at the Pretoria College for Advanced Technical Education and an intensive practical training programme at the Institute's training centre.

Various outside organizations have approached the CSIR with regard to accommodating their students for the practical training periods, and arrangements for this have now been finalized. At least one Government department will be sending its students to this training centre.

#### Computer-aided layout design

A computer-aided design system which was commissioned in December 1973 makes it possible to speed up the production of masks for microcircuits and printed circuit layout and causes them to be less susceptible to human error.

The system has already been used to produce layout data for several monolithic integrated circuit masks as well as layouts for printed circuits for further processing with the numerically controlled artwork generator purchased by the Technical Services Department. An additional staff member has been appointed as an operator for the design system. The operator's duties are the digitization of layout sketches received from the designers.

#### Production of bipolar integrated circuits

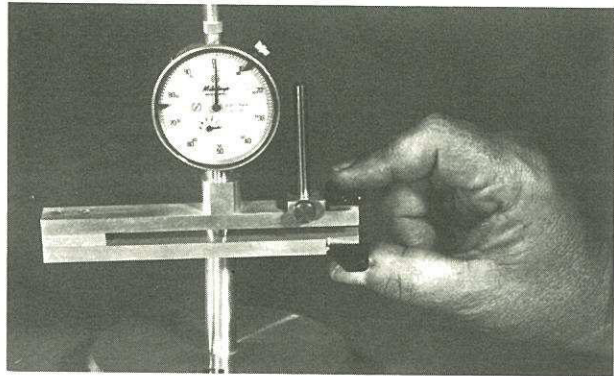
Since 1970, when the first high-temperature diffusion oven was acquired, considerable know-how in integrated circuit technology has been gained, and the stage has been reached where experimental bipolar integrated circuits have been designed and manufactured in the Institute.

Because it is important that South Africa should be self-sufficient in certain products — which include non-standard integrated circuits — a study of various alternatives was made during the year. It was decided that, since industry does not yet provide such a service, the CSIR, as an exception, would provide a small production facility.

Apart from providing circuits for one particular organization, circuits will also be produced for the CSIR's own requirements and for other interested parties, including industry.

In principle, the research team and facilities could be re-organized to carry out routine production of custom-designed or non-standard integrated circuits, but this would be at the expense of any research, and although regular production could not be run efficiently on equipment used for research, certain facilities can be shared.

It was considered essential for the CSIR to enter into an agreement with a semiconductor manufacturer for licencing a bipolar process and technical aid.



A prototype finger-pressure meter designed and developed by the NEERI. This is a purely mechanical device used for quantitatively assessing the rate of improvement from hand surgery.

In order to satisfy the stringent requirements for quality control in integrated circuit production, all the processing steps must be carried out in a controlled environment within a single enclosed area. The planning of such premises has reached an advanced stage.

#### Medical electronics

The telemetry of data required in a sleep study project supported by the Medical Research Council has been extended to the recording of electro-oculograms for detecting rapid eye movement sleep stages and electromyograms in addition to the system for recording electro-encephalograms.

Among the miscellaneous items designed and developed was a finger pressure meter — a purely mechanical device — used for quantitatively assessing the rate of improvement from hand surgery. The surgeon using this maintains that to his knowledge this is the first satisfactory instrument for this purpose.

Automatic measurement of body temperatures of rabbits. To test sera and medicants at the South African Bureau of Standards, these substances are injected into rabbits whose body temperatures are measured throughout the day according to a prescribed time schedule. The NEERI designed an automated laboratory system for this purpose.



# oceanology

## NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY

Director - DR E S W SIMPSON

The National Research Institute for Oceanology (NRIO) was established on 1 February 1974 to take over and merge pre-existing CSIR activities in marine science and technology, and to provide appropriate professional, technical and logistic advice, assistance and support to all South African and foreign organizations as required for their work in the coastal regions and oceans adjacent to South Africa.

In short, NRIO has an obligation to develop where necessary and apply the facilities required for multi-disciplinary basic and applied research in marine science and technology.

The Institute headquarters are at present located in Stellenbosch where comprehensive facilities for coastal engineering and hydraulic model studies (formerly the Hydraulics Research Unit of

the National Mechanical Engineering Research Institute) are already well developed in close proximity to the local university. The East Coast Branch on the Natal University campus in Durban at present controls the research vessel Meiring Naudé and most of the physical oceanographic activities of the Institute which have been inherited from the National Physical Research Laboratory. A variety of CSIR-sponsored research activities at the University of Cape Town (physical-chemical oceanography, marine pollution monitoring, marine biology, geology and geophysics) are also now the responsibility of NRIO where they will be further developed as part of the Institute's multi-disciplinary basic and applied research programme. A few highlights from the research projects currently in progress appear below.



At Stellenbosch the NRIO has at its disposal comprehensive facilities for coastal engineering and hydraulic model studies. Shown in the photograph is a scale model of the proposed south breakwater head for Richards Bay.

### Coastal engineering and hydraulics

During 1974 activities in this field have been mainly concerned with existing, and new, contract investigations. A new group was assembled to tackle the many basic and applied research problems which continually arise in the coastal environment.

Considerable progress has been made with the Richards Bay contract as construction proceeds: the harbour entrance layout was finalized, detailed studies were completed on the stability of the breakwaters, and tests were completed on a large flood and tidal structure being built in the levee dividing the bay into a harbour area and a nature reserve estuary discharging through a new outlet into the sea.

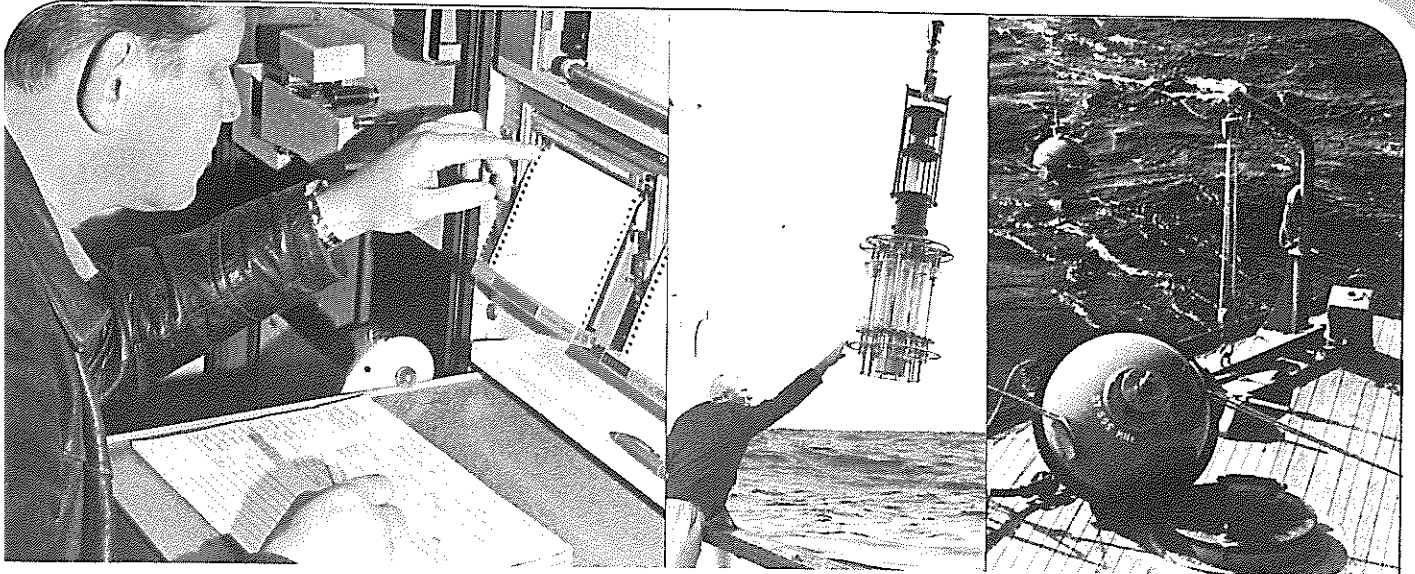
A temporary facility adjacent to the existing model hall, is being built to house models of the proposed Koeberg Nuclear Power Station cooling water inlet harbour and the Gansbaai Fishing Harbour.

Studies of hot-water dispersion, pollution problems and tidal current regimes in Saldanha Bay form part of a multi-disciplinary study of conditions in the bay and Langebaan Lagoon which is essential for the quantitative assessment of the effects of proposed developments in this area.

An appraisal has been made of the Durban Beach Protection Scheme based upon the construction of an underwater mound about 1 km offshore since 1966. A detailed wave refraction study of the Durban bight was used to determine the influence of the partially completed underwater mound on the beaches as far as sediment transport and wave energy is concerned. This will be followed by a review of the present situation and recommendations on alternative or additional schemes.

A project to examine the recreational potential of Natal South Coast Beaches is approaching completion. A detailed study of cause and effect of coastline changes at Amanzimtoti has been





The East Coast branch of the NRIO in Durban controls the research vessel *Meiring Naudé* and most of the physical oceanographic activities of the Institute which had been inherited from the National Physical Research Laboratory.  
 Left: Recordings in progress on board the *Meiring Naudé*. Centre: Deep sea current meter and water sampler being lowered into the sea. Right: Mooring of wave riders.

started with the objective of establishing possible correlations between sea conditions and beach behaviour, so that the appropriate criteria can be more generally applied for predictive purposes.

#### Physical oceanography

Investigations on waves have concentrated upon the effect of the Agulhas current to increase wave energy under those conditions where wave and current directions are opposed. Conditions off the east coast of South Africa offer unique opportunities for acquiring this data. Preliminary measurements made both within and outside the Agulhas current stream in the Richards Bay area suggest that wave energy can be dramatically increased threefold in a strong current. Refinement of our knowledge of critical conditions and predictions of their occurrence will greatly lessen hazards to shipping.

In co-operation with United States workers, NRIO is one of a number of groups to obtain regular meteorological and oceanographic information from the Southern Ocean by satellite retrieval of information gathered by free-drifting buoys which are set free to drift under the influence of winds and ocean currents. Some of these buoys are being assembled locally and their tracks will also be used to solve some of the oceanographic problems closer to Southern Africa. The initial experiments in progress will pave the way for a full-scale international programme.

#### Marine pollution monitoring

A regular series of oceanographic cruises is now being undertaken to collect samples of water and plankton by a specialist group of scientists whose task it is to determine the concentrations of pollutants circulating in world oceans and to identify those which originate in South Africa. Monitoring of metals and other pollutants passing through estuaries, coastal seas and the main ocean currents off South Africa is correlated with assessment of their effects on the flora and fauna. The large natural variations in some metal concentrations are being investigated in order to distinguish natural fluctuations from those due to pollution inputs.

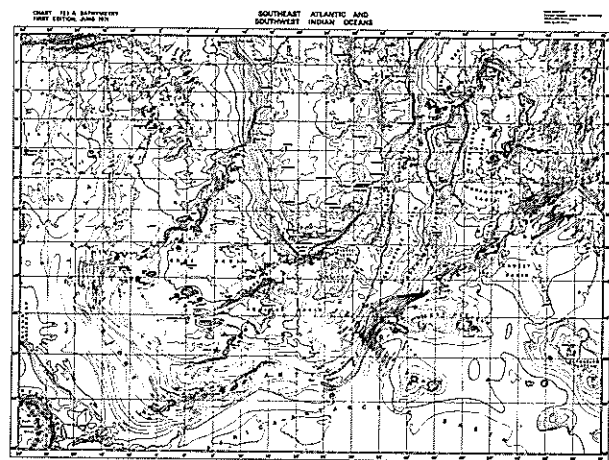
#### Deep sea drilling project

The initial report of 884 pages describing the results obtained during Leg 25 of D/V *Glomar Challenger* (Mauritius to Durban, June to August 1972) has been compiled and was published during 1974.

#### International marine scientific activities

The Director of NRIO has been particularly involved during 1974 with the following aspects of his many international marine scientific activities:

- Election as Chairman of the General Bathymetric-Chart of the IOC/IHO Guiding Committee for the Oceans (meetings in Paris and Monaco). Compilation of the first five charts is in progress.
- Finalization of the content and arrangements for publication in Moscow during 1975 of the International Geological/Geophysical Atlas of the Indian Ocean.
- Compilation from international data sources of Chart 125A showing sea-floor relief of the South East Atlantic and South West Indian Oceans.



# mechanical engineering

## NATIONAL MECHANICAL ENGINEERING RESEARCH INSTITUTE

Director - DR H G DENKHAUS

While the National Mechanical Engineering Research Institute (NMERI) is concerned mainly with the development of new processes, techniques and equipment in mechanical engineering as well as the improvement of machines and materials used in industry, it is also active in fields such as geomechanics for both mining and civil engineering as well as in civil engineering hydraulics. Testing equipment, machines, instruments and qualified personnel are available for research in six divisions covering the fields of metallurgy, strength of materials, process development, geomechanics, fluid mechanics, heat mechanics (including air conditioning and refrigeration) and a special unit dealing with aeronautics.

The six divisions and the Aeronautics Research Unit are housed in Pretoria, while the Mine Equipment Research Unit is accommodated in Johannesburg. The two units are integral parts of the Institute and are responsible to the Director of the Institute.

### Spherulitic graphite iron

Spherulitic graphite, or SG iron, is a cast iron which has the favourable casting properties of grey cast iron and most of the superior strength properties of cast steel. It can be used for castings of intricate design, for gears, camshafts and pulleys and even for crankshafts in internal combustion engines.

In SG iron the graphite appears in the form of nodules and not in the form of lamellae as in cast iron. The nodular shape is the reason for the enhanced strength of the material. The nodules are produced by inoculating cast iron with suitable spheroidizing agents of which magnesium and its alloys are very common.

Research at the National Mechanical Engineering Research Institute is aimed at learning more about the mechanism of the inoculation process in order to improve the technology involved in the production of what is believed to be a potentially very useful material in the Republic.

### Metal fatigue damage

When a structure or machine is subjected to alternating loads the metal from which it is made fatigues. This phenomenon has been the subject of considerable research over many years in many countries. In most of this research and, in fact, in the standard methods of determining the fatigue strength of a metal, the test specimens are subjected to a varying load of constant amplitude alternating between fixed upper and lower limits. In



Pouring molten metal from a furnace in the foundry laboratory of the Metal Mechanics Division.



practice, however, the loading suffered by metals does not usually conform to the orderly loading cycle applied in the test and research is being done in the Strength Mechanics Division into the fatigue behaviour of metals under random loading conditions.

The present objectives of the research are to determine the influence of such factors as geometry and size of component and the mean load on the accumulation of fatigue damage under various random loading conditions.

In the laboratory an investigation to determine the interaction between high and low load amplitudes under axial loading conditions was completed in order to obtain the influence of stress levels on the history of the propagation of macro-cracks in mild steel. Tests were also done on specimens of structural parts in which the flight and landing loads were similar to those experienced by the aluminium rotor blades of the autogyro which was built in the Aeronautics Research Unit. These tests are obviously vital to ensuring the safety of the autogyro in flight.

### Geomechanics services to industry

Rock mechanics is a relatively new science and has been applied to practical problems in the field only within recent years. The Institute has been in the forefront not only locally, but also internationally, in rock mechanics research, particularly in its application to mining and civil engineering problems, and offers a consulting service to civil and mining engineers who are taking full advantage of it. It also maintains a team to measure the stresses in the rock mass in situ, where required. Facilities are available for determining the strength and other properties of rock required in the design of mining excavations, tunnels, slopes and foundations in rock. For example, in one investigation the stresses in the rock surrounding the excavations for the Ruacana Power Station which is part of the Cunene River scheme in South West Africa were measured in situ. The results were used by the consulting engineers in designing a support system for the large underground caverns.

Another development in connection with in situ tests was that up to the present it had always been necessary to bring rock specimens from the field to the laboratory to determine their strength and other properties. A portable point-load strength tester has, however, been developed and manufactured by which the relevant information can now be obtained in the field. Laboratory and field tests have shown it to give reliable and consistent results. An inexpensive single point rod extensometer having a gauge length of about 5 m was also designed and manufactured. This was used in two different tunnels in the Transvaal to measure rock displacement. In one of the tunnels (a railway tunnel), convergence measuring devices were also installed. Site staff and the contractor's staff were instructed on the installation and measuring procedures as well as the interpretation of the readings obtained. By means of the readings a continuous check can be kept of the stability of tunnels and other excavations.

### Strength of coal pillars in collieries

A major investigation sponsored by the Coal Mining Research Controlling Council into the strength of the unmined coal pillars left to support colliery workings was completed during the early part of 1974. The results, which were obtained by actually measuring the strength of pillars in situ in various collieries, threw light on the minimum size of pillars which can safely support the working, and should be an invaluable guide to colliery engineers at a time of world energy problems when the need for maximum coal extraction is being emphasized.

### Stability of rock slopes

A survey of the literature published throughout the world dealing with the design, monitoring and improvement of the stability



The Geomechanics Division undertook an analysis of the stability of the entrance to this tunnel to establish whether further collapses might occur.

of rock slopes has been carried out and the information has proved invaluable in several investigations. In one investigation, involving the stability of the slope of the open-cast De Beers diamond mine in Kimberley, after a visit to the site, discussions with various persons concerned, an examination of the history of the mine from technical reports and other data and calculations based on slope stability investigations conducted previously, it was concluded that there was no immediate danger of sudden collapse of the mine slopes. However, since it was not possible to guarantee that the slopes would be stable forever, appropriate recommendations were made.

### Air conditioning

Under the climatic conditions prevailing in Southern Africa air conditioning of working space is in many regions desirable to enhance comfort and consequently efficiency. This, however, can be expensive and, because of the subjectivity of comfort feeling, is often unsatisfactory. It is therefore necessary to develop methods which allow a quick assessment of the efficiency of a proposed installation, bearing in mind that a high degree of comfort is expensive while a lower but still acceptable degree of comfort may be financially tolerable.

A computer program was designed for estimating the cooling and heating energy requirements specifically for multi-storey office buildings but also applicable to most other structures. The program computes the hourly cooling or heating load due to solar radiation through windows, heat transmission through external and internal walls and the roof, as well as the load due to occupancy, lighting, infiltration and ventilation. When run on a yearly basis, the program can be used to predict the total energy consumed by an entire air conditioning system during an average year of operation. The program is intended as a basic aid for engineers involved in the design, selection and evaluation of air conditioning systems and was successfully used in a number of applications.

### Refrigeration

The effect of environmental conditions such as temperature, humidity and air velocity on the quality of meat during chilling is being investigated. Tests are carried out in experimental cold rooms that were specially designed by the Institute to study correct chilling, storage and freezing procedures for meat. Special measuring devices were developed in order to accurately record moisture losses as well as heat loss rates from carcasses during chilling. The work is performed in close collabora-

tion with the Livestock and Meat Industries Control Board and the Division of Veterinary Services of the Department of Agricultural Technical Services.

#### Heat exchangers

The Institute is concerned with a project aimed at optimizing the design of natural-draught dry cooling heat exchangers for applications in the power generating industry. Investigations, sponsored by the Water Research Commission, were carried out with the object of arriving at a high performance heat exchanger which will result in a reduction of the overall cost of a dry-cooling tower system, which is so important for saving water.

Based on results of these investigations a report, which describes a method of evaluating the performance of different types of heat exchangers in natural-draught dry-cooling systems, was completed.

Tests were also carried out to determine the performance of hot water operated panel radiators and steam heating coils under controlled laboratory conditions.

In addition, advice was given on various aspects of the design and operation of timber drying kilns as well as on the optimization of a heat rejection system for a brewery.

#### Fuel saving devices

The energy crisis has led the Heat Mechanics Division to investigate the use of producer gas generated from coal as an alternative fuel in internal combustion engines, especially diesel engines. During the year numerous suggestions were received from organizations and individuals outside the CSIR for saving fuel and their feasibility was studied. Fuel-saving devices and gadgets sent in to the Division were subjected to performance tests to confirm or refute the claims made for them.

#### Automatic irrigation gates

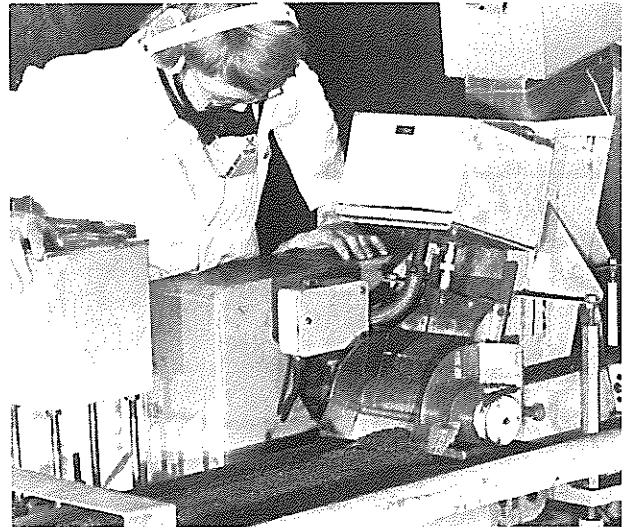
Three types of irrigation gates namely scour, crest and regulating gates which have been developed and are being manufactured in South Africa, were submitted to the Fluid Mechanics Division for tests to determine their operational performance characteristics including their discharge coefficients.

The scour gate is used in dams to prevent silting by discharging silty water during floods and to restore storage capacity by scouring out settled materials. The crest gate is used in dams to increase the storage capacity and to release excess water and floating debris automatically during large floods. The regulating gate is used to supply a required amount of water independent of the upstream head in an irrigation canal.

These tests have established the need to extend the investigation to include the optimizing of the valve control system on the regulating type of gate and the controlling of a series of gates with the ultimate aim of developing a complete water control system from the water supply source down to the various demand points which could help to save large quantities of water.

#### Hydraulic transportation of coal

In a scheme designed to transport coal in the form of a slurry from collieries of Northern Transvaal to Richards Bay harbour, the consultants involved in the project required the determination of certain important parameters for the design of the pipeline. Investigations were carried out in the laboratory's pipeline test circuits in pipes 100 mm, 200 mm and 250 mm in diameter to determine the pressure gradients when pumping coal slurries of different particle size distributions, solids to



Hydraulic transportation of coal over long distances is being investigated by the NMERI. Coal is being conveyed from this feed belt scale into a rod mill in which the slurries are prepared.

water concentrations and slurry velocities. This will enable a decision on the number and location of pump stations to be made. When built, this will be the first major pipeline in the Republic transporting solids over long distances and it is planned to use it for conveying several million tons of coal per annum over several hundred kilometres.

#### Light-weight aggregates

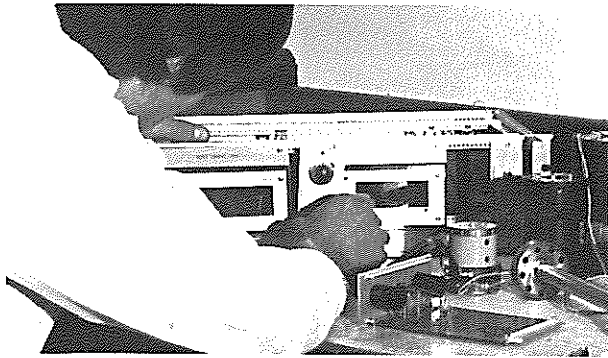
Light-weight aggregates, sometimes having a relative density of less than unity, are produced overseas from expandable clay and to a lesser extent from fly ash. Their use in concrete structures results in considerable reduction of the overall dead-weight compared to the use of conventional aggregates. To reduce the cost and at the same time dispose of a waste material, the use of fly ash from power stations has been suggested for the production of light-weight aggregates in South Africa.

Investigations have continued during the past year using pellets made from fly ash, to which various additives have been added, to give strength to the green pellets and expandable qualities during the burning process. A fluidized bed reactor has been used in which to burn the pellets. Since the green pellets crumble under the slightest impact when dry, suitable binders which do not influence the burning properties of the pellets are being tried to improve the impact strength of the green pellets and hard light-weight aggregates with relative densities of 1,1 have been produced. Further studies, however, are required on alternative inexpensive additives such as coal dust and wood flour to reduce the density of the aggregates still further without decreasing the strength of the final light-weight concrete.

#### Harbour research

The research into the hydraulic aspects of the development of Saldanha Bay as a harbour was completed during 1973. The hydraulic model, however, is being kept on a maintenance basis for any future studies that may be required by the client. During





A technician in the Strength Mechanics Division engaged in building a special transducer for an industrial client.

the past year, however, the question was posed as to what the effect on the temperature of the water in the Bay would be of discharging up to 100 000 m<sup>3</sup>/h cooling water 10 °C above ambient temperature into the Bay from the semi-steel production plant planned by ISCOR.

The problem is being investigated by a CSIR working group from four CSIR Institutes including the Heat and Fluid Mechanics Divisions of the NMERI.

#### Testing of steel winding ropes

The Mine Equipment Research Unit at Cottesloe is responsible for the statutory testing of all the steel winding ropes used in the mines throughout the Republic. Late in 1973 a new test facility was commissioned; this test facility which incorporates many refinements cost over half a million rand and has, during its first year of operation, produced most gratifying results.

#### Design of mine winding ropes

The great depths at which mining operations are conducted in South Africa present problems which are not normally encountered in the mining industry overseas. The Mine Equipment Research Unit pays particular attention to the design of steel wire ropes used for hoisting men, materials and rock.

An important aspect of rope design, with particular reference to Koepe winders, is resistance to fatigue. A special universal wire rope fatigue testing machine is being used at the Mine Equipment Research Unit to carry out investigations in this field. The results obtained are being used to develop types of ropes best suited to local conditions.

#### Autogyro development

The design and development of a two-seater autogyro type aircraft in the Aeronautics Research Unit is a project which was selected to provide research problems in all three of the Unit's main fields, namely aerodynamics, structures and propulsion with the object of contributing towards the knowledge and experience essential to the country's developing aircraft industry. If successful such an aircraft should also find important fields of application in South Africa. The design and building stage of a prototype aircraft has been completed and provided the research team with challenges which could not be foreseen when the project was formulated, but which have each been

successfully met. Now that the aircraft is flying, the team has a flying test vehicle which enables further invaluable experience to be gained.

For example, analytical studies and flight testing aimed at reducing vibration problems experienced with the rotor were carried out, and reasonable vibration levels were attained with fairly stiff metal rotor blades. Investigations into the dynamic behaviour of these blades are still being continued. The latest flights with the autogyro are mainly concerned with take-off performance. A recent modification which in no way detracts from the simplicity of the machine has resulted in take-off roll distances of as little as 27 m in Pretoria summer conditions (1 460 m above sea level, 25°C air temperature).

Considerable effort, however, is also being spent on developing relatively flexible fibre glass rotor blades, a pair of which were tested in the laboratory and subjected to preliminary flight trials on the autogyro. The tests revealed problems, however, which have tentatively been diagnosed as being of an aeroelastic nature. Successful development of fibre-glass autogyro blades is regarded as important also from the point of view of the possibility of manufacturing helicopter rotor blades in South Africa.

#### Aircraft noise

The Institute continued to participate in work of the International Organization for Standardization (ISO) concerned with preparing draft proposals for standard procedures in predicting exposure to aircraft noise when planning the use of land. South African proposals are based on methods previously developed by the Institute's Aeronautics Research Unit and accepted by the South African authorities for the purposes of controlling development of residential areas around local airports.

During the year particular consideration was given to extrapolation procedures used in the assessment of noise disturbance in such land use planning. South African experience and concern in this connection stems from the local need to assess noise disturbance at airports under differing conditions of altitude and temperature by extrapolation from noise measurements made under 'standard' conditions.

#### Low speed wind tunnels

The wind tunnels at present available in the Republic were designed to fulfil certain requirements and up to the present there has not been the necessity for one with a very large working section. Pending official approval for building such a facility feasibility studies have been done on a model of a multifan open circuit layout having a tunnel working section of 7 m wide.

Three alternative tunnel inlet layouts were studied. These included a conventional inlet flare with contracting side walls, a small inlet flare with a novel straightener vane system designed in accordance with potential flow theory and a small inlet flare with a conventional straightener honey-comb and no side wall contraction. It was found that poor flow distribution resulted with the latter inlet design but that the other inlet configurations gave satisfactory flow characteristics in the working section. The multifan system functioned satisfactorily for all configurations.

Since the full-scale tunnel is to be situated in the open atmosphere its operation would be influenced by natural winds. Tests to compare the various inlet configurations, using very small scale models, showed that the potential flow straightener vane system was more susceptible to external winds and this caused undesirable flow distributions in the tunnel working section.

Considering the results of the various studies it appeared that a tunnel having a large inlet flare and a conventional contraction would be the most suitable.

# building research

## NATIONAL BUILDING RESEARCH INSTITUTE

Director - DR T L WEBB

The National Building Research Institute (NBRI) works closely with the building industry, the professions and the public sector to seek and to apply solutions to problems facing the industry and to develop technology and criteria for improving the built environment. Its work has been guided for almost 30 years by the Building Research Advisory Committee (BRAC), on which some forty representatives of universities, institutes and other public and private sector bodies serve.

The work of the NBRI was, during its early and developing years, confined to technological fields. It has however gradually evolved, largely to meet the industry's and the country's needs, into a body increasingly orientated towards the building and construction industry and today its activities cover matters such as organization, financing and management in the industry as

well as the traditional technological fields of investigation such as soils, materials, structures, the built environment, services and design.

The size of the industry which the NBRI serves is shown by the investment of R2 600 million in the year 1973-74. The Institute's total budget for the same period, namely R2,3 million, was rather less than one tenth of one per cent of this investment. During the year the NBRI earned 39,5 per cent of its total running expenses, largely from 380 contract investigations it undertook during the period. The Building and Construction Advisory Council (BCAC), which advises the Government on matters regarding building and construction policy, continued its efforts to secure substantial additional funds to enable the NBRI to meet growing demands, and made special representations to Government in this connection.

### Regional offices

Regional sub-committees of the Building Research Advisory Committee guide the work of NBRI offices in Durban, Cape Town and Windhoek and the opening of a fourth regional office, in Port Elizabeth, is being planned.

### Congresses, symposia and committees

The main event under this heading was the Third South African Building Research Congress. This took place in Durban in May and was attended by some 800 delegates, of whom a quarter came from foreign countries. A festival of building films, which attracted wide international participation, and a building exhibition were organized to coincide with the congress. Immediately following the congress, a symposium on National Building Regulations, organized jointly by the South African Bureau of Standards and the NBRI, was held. Two-fifths of the papers presented at the congress and symposium were by overseas authorities.

A two-day symposium on sewerage and drainage, attended by 400 delegates, was held in Bloemfontein during October.

During the year under review, NBRI staff served on or contributed to the work of 142 committees which promote the interests of the building industry in South Africa and abroad. Staff members delivered 111 lectures and participated in 41 local and overseas conferences, presenting 25 papers. Twenty radio talks were also prepared and broadcast.

The Director of the NBRI was appointed by the State President as chairman of a commission of enquiry into the education and training of architects in South Africa. He also became the se-

cond person to have honorary membership of the South African Institute of Building conferred on him.

### Films and exhibitions

The NBRI's exhibit prepared for the Durban building exhibition mentioned above was also presented at the Fourth International South African Building Exhibition in Johannesburg (during which the NBRI also arranged a seminar), and at exhibitions in Salisbury, Windhoek and Cape Town.

### Use of computers in building and construction industry

The NBRI continued to provide the secretariat to the Standing Committee on the Use of Computers in the Building and Construction Industry and to operate the Construction Industry Computer Information Centre set up in the Institute by the Building and Construction Advisory Council. As part of its work, the overseas manager of the Genesys Centre in Britain was invited to give a series of lectures and to hold seminars in Johannesburg, Pretoria, Cape Town, Durban and Windhoek, all of which were well attended.

### Fire investigations

A satisfactory horizontal fire test furnace has been commissioned and tests have been done on ceiling and floor slabs. In addition, a multi-purpose test structure for fire research consisting of a fireroom, corridor, staircase and four-storey section was built during the year. Test work began with a series of carpet tests in the corridor.





Testing floor coverings for wear with a carpet wear simulator.



The NBRI is investigating in collaboration with a number of bodies causes of deterioration of rock paintings and engravings in order to develop methods of preserving them.

The NBRI's programme of carpet testing has shown the need to develop and apply performance criteria for soft floor-coverings. Most carpets submitted for fire testing have performed badly, though recently there has been a marked improvement.

Since most deaths in fires are caused by smoke and gases, relevant measurements were made during testing and have been used to establish tentative performance criteria for permissible smoke production.

The contribution of plastics to flame spread and smoke production is also being assessed, and the Institute has initiated action aimed at controlling the use of flammable plastics in buildings.

NBRI staff have also established that there is a severe fire hazard in many South African high-rise buildings, and have made recommendations aimed at reducing this risk.

#### Industrial noise

Among other work on the alleviation of industrial noise, a major industrial plant was surveyed to determine the risk of damage to hearing to which personnel were exposed. Noise sources were identified and treatments recommended. A particular problem was the design of noise abatement equipment suitable for use under adverse environmental conditions, and a general specification has been produced for incorporation in future tenders.

#### Preserving history

The NBRI is working on programmes concerned with the preservation of historically valuable buildings and art forms. For example, plaster failures in a historic building in Graaff-Reinet were identified as being caused by rising damp, and appropriate recommendations made to prevent further damage. Similarly, it is investigating, on a sponsored basis and in conjunction with the National Monuments Council, the Action Group on Rock Art for Africa and the Archaeology Department of the University of Pretoria, causes of deterioration of rock paintings and engravings in order to develop methods of preserving them.

#### Brick-veneer housing

A technical guide on timber-framed brick-veneer housing is being prepared in collaboration with the Department of Forestry

and the timber industry. Two such systems are being assessed for Agrément certificates and a survey is being carried out into the attitudes of occupants to establish the acceptability of this type of construction, and to identify any thermal, acoustic and other performance differences that may affect their acceptability.

#### Wind gusts in thunderstorms

Little has been done in the past to study wind turbulence during thunderstorms and its effects on buildings. These phenomena cannot be described in the familiar statistical sense and the measurement of gust velocities in thunderstorms are expected to yield valuable information to building designers.

During the past year a wind velocity sensor which had to meet stringent requirements regarding low temperature drift, good aging stability, extreme ruggedness, high frequency response and low cost has been developed and partially tested. At present the prototype is unacceptably sensitive to azimuth angle changes and further aerodynamic modifications are necessary. Before acceptance the prototype will be tested against a sonic or hot-wire anemometer.

#### Waterproofing flat roofs

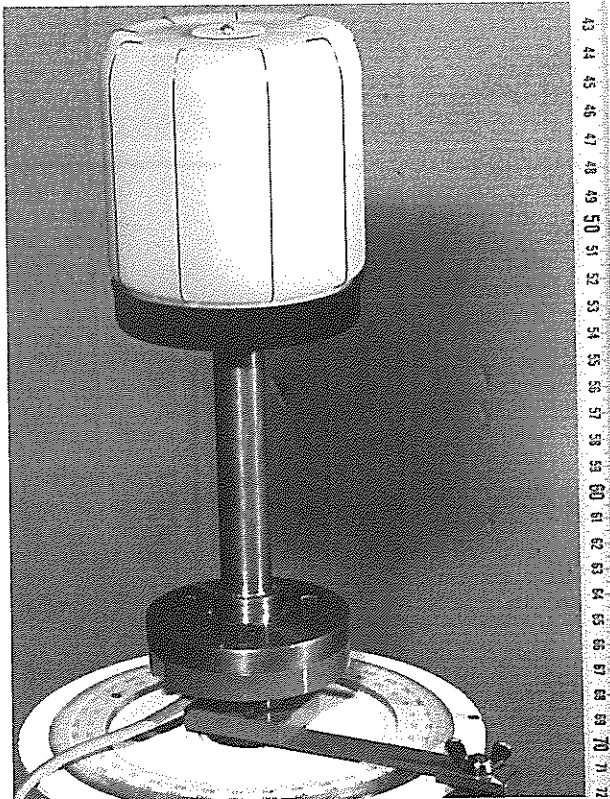
Failures in the waterproofing of flat roofs continue to be a serious problem and a programme has been initiated to establish meaningful criteria for roof waterproofing materials.

Many failures attributable to thermal movement can be prevented by thermal insulation and a programme to study the performance of such materials has been initiated. It has been found that certain coatings commonly used as protection are unsuitable and may in fact be harmful. Various other coatings studied appear to offer protection and these will be studied over a longer period.

#### New rubber on trial

About 1 200 kg of a special blend of EPDM-styrene rubber developed by the NBRI was made up by a South African factory and used on the roof of the south wing of the NBRI building in Pretoria. Interest in this development has been keen in Europe and two invitations were received to read papers on the subject.





A wind velocity sensor designed for a research programme aimed at testing the stability of high buildings in wind gusts. The measurement of gust velocities in thunderstorms are expected to yield valuable information to building designers.

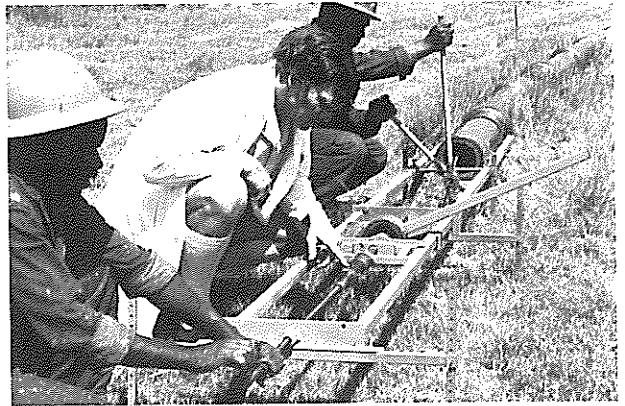
Further research on blending EPDM with other rubbers is in an advanced stage and it has again been shown that the weather resistance improves beyond expectation as long as high-styrene rubber is present together with EPDM.

#### Information dissemination

The final draft of the new *Construction indexing manual* detailing proposed revisions to the CI/SfB classification system has been studied in detail and comments submitted to the publishers. These were so extensive that it has been decided to postpone the proposed CI/SfB workshop sessions until the new manual is available. Assistance was given in setting up a Construction Industry Information Group in Johannesburg, for the discussion of building information systems at monthly meetings.

#### Agrément Board

The NBRI serves as the evaluating agency for the Agrément Board of South Africa, set up some five years ago on the recommendation of the NBRI in order to assess innovative methods and systems of building and novel components and materials. To help it with its work for the Board, the NBRI has, among other things, installed a wear simulator for evaluating floor-coverings. The problems posed in preparing evaluation programmes for flat roof coverings and a three-dimensional box-unit building system have also led to the development of new performance criteria.



Testing the effectiveness of cleaning curved sewers with traditional sewer-cleaning equipment. The tests led to a recommendation that manholes need be spaced no closer on curved sewer lines than they are on straight sewers.

Furthermore, in order to make the certificates issued by the Agrément Board more meaningful, the NBRI developed and proposed to the Board a graphical method of presenting information on the thermal behaviour and acoustical performance of building systems. In the case of thermal behaviour, the information relates expected maximum and minimum thermal conditions to orientation, degree of fenestration and the type of floor covering used, in six climatic regions. Both these methods of presentation are now being used.

#### International co-operation

The NBRI is a member of 26 international organizations concerned with building research, and takes part in the activities of a number of working groups and study committees. The Institute's Director serves on the board of the International Council for Building Studies and Documentation (CIB), and is South Africa's representative on the permanent committee of the International Union of Testing and Research Laboratories for Materials and Structures (RILEM). He was also invited to serve as chairman at the five-yearly meeting of Directors of Building Research in English-speaking Countries (DESBRO), which took place during the year.

In addition to maintaining close collaboration with a number of building research organizations in most overseas countries, information and advice was given to bodies in Canada, Brazil, Rhodesia and New Zealand on the organization and setting up of building research and related organizations.



# food research

## NATIONAL FOOD RESEARCH INSTITUTE

Director - J.P. DE WIT

The main aim of the National Food Research Institute (NFRI) is to promote effective utilization of South Africa's food resources. Its activities include both fundamental and applied research into aspects of food composition, utilization, preservation, packaging and storage, as well as product and process development.

The Institute consists of four research divisions: Food Chemistry, Food Technology, Biological Evaluation and Techno-economics. It also administers and is closely associated with the Microbiology Research Group of the CSIR and the Bantu Beer Unit.

Typical fields of activity are food processing, cereal technology, food packaging and storage, flavour chemistry, food microbiology, food analysis and food chemistry. Biological studies of the utilization of nutrients in foods and diets are also undertaken.

### The role of vitamin C in the body

Vitamin C is an essential dietary component in some species of fish, the guinea-pig and certain higher primates, including man. A deficiency in this vitamin gives rise to metabolic changes of a severity depending on degree of deficiency, a severe deficiency resulting in scurvy.

Studies in the course of a research programme on the role of vitamin C in the body of a higher primate, the baboon, have revealed in particular two facts of considerable importance.

Firstly, an observed rise in blood cholesterol levels following intravenous administration of vitamin C could mean an induction of withdrawal of cholesterol from its stores in blood vessels, where cholesterol deposits can cause a characteristic thickening of the walls known as atherosclerosis. Vitamin C administration also lowers blood fat levels.

Secondly, it was proved that vitamin C has an effect on the blood levels of two compounds which are regarded as very important in the light of recent work by biochemists, *viz.* cyclic adenosine monophosphate and cyclic guanosine monophosphate. These compounds control various processes in the body, e.g. cellular growth and blood coagulation. Intravenous administration of vitamin C induces an increase of the first and a decrease of the second of the above compounds in the blood serum levels.

### Amino acid requirements of the rat

Since the amino acids form the 'building blocks' of proteins in the body and the laboratory rat is the animal conventionally employed to assess the physiological usability of dietary proteins, the amino acid requirements of the rat is a topic of fundamental importance.

Studies relating to this revealed the significant fact that the amino acid requirements of the rat do not form a constant pattern, but one that can vary under certain conditions. Thus the requirements for several amino acids relative to that for tryptophan when the animal is in a nitrogen balance status of zero differ from the requirements at a balance status of 100 mg/100 g body mass/8 days. The animal most probably undergoes adaptational changes when it is subjected to a state of low nitrogen balance, such changes leading to conservation of certain amino acids and a temporary decrease in the animal's needs for such amino acids.

The results obtained highlight the need to find experimental conditions in which the effects of adaptational changes are minimal. Such conditions would be the most suitable for the testing of dietary protein values.

### Grading of grain sorghum cultivars

According to results obtained previously, South African sorghum grains differ considerably from one cultivar to another in the ability to support growth in animals, the difference being due to variations in digestible protein content. In view of this, an *in vitro* method was developed for rapid determination of digestible protein content. This method was then used to investigate 49 different seed samples with a view to presenting an overall picture of the digestible protein contents of all the more important cultivars currently used in grain sorghum production.

### Diet and tissue calcification

Continuation of a long-term investigation into the relationship between diet and the formation of calcium structures in the body revealed interesting differences between the rat and the

baboon in regard to the effect of a specific nephrocalcinogenic diet.

Whereas the above diet — characterized by a low magnesium and a high phosphorus content — induces in the baboon calcification in both kidney and adrenal whilst reducing serum magnesium and calcium levels, it induces in the rat calcification of only the kidneys, whilst reducing serum magnesium and increasing serum calcium levels.

#### New maize products

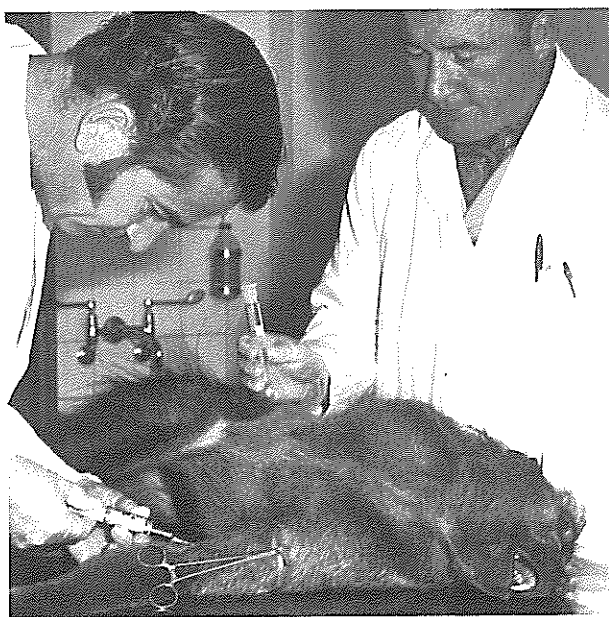
The Institute developed two new products based on the Latin American maize products, arepa and tortilla. This forms part of an investigation into the manufacture of new maize products in order to promote the use of maize as a food. It was realized that instant or ready-cooked products held more possibilities as it will not be easy to teach the consumer the traditional methods of preparation; furthermore, there is a need for ready-cooked maize products.

The preparation of instant arepa meal has so far proved very successful; this meal is mixed with salt and water and the resultant dough is cooked for 2 to 3 minutes on a plate or in oil. The product has already been tested on a restricted scale by consumers and the results have been very promising.

#### Vegetable juices

Since interest was shown by the food industry in manufacturing certain vegetable juices, the Institute started investigating the manufacture of carrot and beetroot juices. It was found that conventional methods could not be applied but good results were obtained by exploiting the action of the enzyme complex found in the tomato. The process is relatively simple and juices with an attractive appearance and taste, and good yield were prepared.

Blood samples are being drawn from a baboon. The purpose of the experiment is to establish whether or not there is a quantitative difference in the secretion of a specific enzyme between, on the one hand, baboons fed vitamin C at a high dietary level and, on the other, animals on a low consumption level of the vitamin.



The NFRI developed two new products based on the Latin American maize products arepa and tortilla. This work forms part of an investigation into the manufacture of new maize products in order to increase the use of maize as a food. The photograph shows tortillas being prepared.

#### Food processing on a small scale

A new project is the evaluation of experimental vegetable and fruit varieties by means of small scale processing on behalf of the Horticultural Research Institute of the Department of Agricultural Technical Services. This service means that new varieties need not be tested on an industrial scale where large amounts of materials are needed and normal production has to be stopped during testing. Special attention is paid to the canning, freezing and dehydration of vegetables and the canning of fruit. The characteristics of the experimental varieties are assessed on the basis of behaviour during processing as well as physical and sensory evaluation of the end product.

Experimental tomato varieties have inter alia to be evaluated in respect of their suitability for the manufacture of tomato paste. The procedures for production of tomato paste on industrial scale cannot be easily simulated on a small scale, but the Institute has developed a satisfactory small-scale technique for the preparation of tomato paste.

The past year has been characterized by increasing liaison with the food industry and use of the facilities of the Institute by the food industry.



### Salmonella-infected fresh meat products

Following studies which showed that bovine biltong on the market may be infected with salmonella serotypes, other commercial fresh meat products were investigated. Samples of these products were purchased from retailers in Pretoria and are representative of food which is bought by the public.

Of the 30 samples of pork sausages investigated (representative of 5 manufacturers), 12 (representative of 4 manufacturers) were infected with serotypes *Salmonella typhimurium*, *S. thompson*, *S. johannesburg*, *S. london* and *S. adelaide*. In the investigation of 11 samples of mincemeat (obtained from 11 butcheries), 7 were found to be infected with *S. typhimurium*, *S. johannesburg* and *S. newport*. Twenty chicken carcasses were investigated and 2 of the 10 frozen and 2 of the 10 refrigerated were infected with *S. thompson*, *S. newport* and *S. london*.

Of the six serotypes encountered, *S. typhimurium* and *S. thompson* were prevalent. These two serotypes are known to cause gastro-enteritis.

From a national health point of view salmonella infection appears to be one of the most urgent problems facing the meat industry.

### Commercial preparation of citric acid

Preliminary investigations in which specific by-fractions of SASOL hydrocarbons were used as substrate showed that a yield of 20 g citric acid per litre of fermenting liquid could be obtained. An inherent disadvantage of this type of substrate, however, is that considerable quantities of the technically unimportant isocitric acid is formed at the same time. This represents a loss in substrate. Research was then directed towards improving the micro-organisms used by means of a mutation and

selection programme and by utilizing more promising substrates.

Results based on the investigation of 1 057 mutants showed that the use of glucose (which can at present be obtained quite easily from maize) as substrate not only doubles the yield of citric acid but reduces the formation of isocitric acid fivefold. These yields obtained on laboratory scale represent a 70 per cent utilization of the substrate.

An additional advantage of the proposed process is that the spent yeast can be reclaimed for use as animal feed.

### Techno-economic activities

During the past year a Techno-Economics Division was established in the Institute. In the field of food research techno-economic surveys to determine research needs of food manufacturing sectors can be undertaken by the Division. This includes the economic appraisal of these needs, assistance in the evaluation and planning of research projects and economic advice in the implementation of research results. At this stage, the Division is involved in the projects regarding marula processing (which was mentioned in the previous annual report) and in the project on the production of citric acid.

For the Bantu Beer Unit, the Department of Bantu Administration and Development and the Bantu beer industry, the Division undertakes cost and feasibility studies, market surveys and the development of management information systems.

Research was also undertaken into the transportation of Bantu beer and a comparative study made of the effectiveness of different brewing enterprises.

### Flavour components of Bantu beer

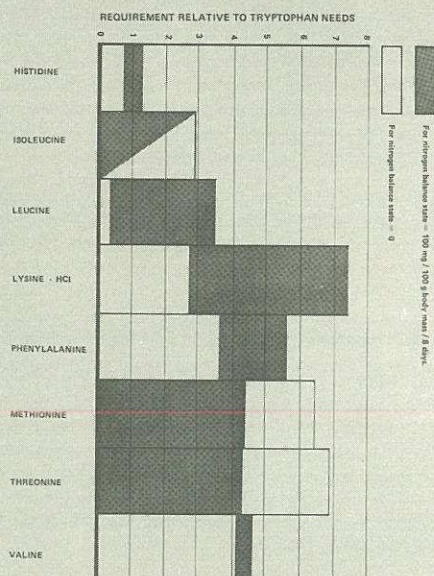
The qualitative composition of flavour extracts of Bantu beer were investigated using different types of columns for gas-chromatographic separation and subsequent mass spectrometric analysis. Altogether 38 new compounds could be identified. In the volatile fraction which constitutes the aroma of Bantu beer, eleven compounds could be identified.

### Analytical methods in flavour research

Because of the large variety of volatile chemicals which contribute to the flavour of food, it is necessary to develop sophisticated methods of studying flavour. The use of coated capillary columns in gas chromatography is one of the best methods of separating complex mixtures into individual components.

The Institute has recently developed an improved method of coating the inner wall of glass capillary tubing with a variety of chemical reagents including polar liquid phases. Obtaining an evenly coated glass capillary column with a 'non-wetting' polar phase was previously an extremely tedious task. The capillary columns which the Institute is now able to prepare are effective aids in defining the complex chemical nature of flavour.

Amino acid requirement (expressed relative to requirement for tryptophan) of young rats for the maintenance of certain states of nitrogen balance, viz., zero and 100 mg nitrogen per 100 g body mass per 8 days. The figure illustrates the fact that amino acid requirements vary according to the state of nitrogen balance.



# personnel research

## NATIONAL INSTITUTE FOR PERSONNEL RESEARCH

Director - D J M VORSTER

The optimum utilization of labour resources is of the utmost importance in South Africa with its acute manpower shortage, especially in respect of skilled labour. The National Institute for Personnel Research (NIPR) therefore devotes considerable attention to this problem, and there is hardly a sector of industry which has not benefited to some extent from its work.

In any work situation there are certain factors directly affecting the worker's productivity and happiness. The NIPR is concerned with the study of these factors, which include:

- definition of the characteristics of work, i.e. description of the job, analysis of the physical and psychological demands made by the job on the worker, evaluation of a specific task in relation to others, and determination of the skills involved in work;
- selecting and placing the right man in the right job (by means of aptitude tests, interests tests, and others), giving him the necessary training, and assessing his performance;
- fitting the job to the man by improving working conditions and equipment;
- studying the socio-psychological aspects of work, e.g. manpower problems, social relations in the work situation, work motivation and attitudes;
- investigation of problems arising from maladjustment to work, e.g. absenteeism, accidents, occupational disorders and group conflicts.

### Shortage of Black graduate staff

The Institute has in the past employed, in any one year, up to seven Black graduates. Qualifications have been either the B.A. or B.A. (Hons.) degrees.

These staff-members have proved invaluable, over the years, in many divisions of the Institute, but mainly in the Industrial Ethnology Division. Here they have acted as interviewers of Black subjects in projects of many kinds: attitude and morale studies, studies of absenteeism, labour turnover and motivation, and operational surveys. Their assistance in the interpretation of data has been of considerable value.

In the past it was usually possible to keep these staff-members for many years, mainly because there were few employment opportunities outside the Institute with comparable conditions of service. A marked change has, however, taken place in industry and commerce, and today there are many openings for Blacks in the personnel management field. The result has been, in the last year, that all experienced male staff-members have left, and it has not been found easy to replace them. This has adversely affected progress in the Industrial Ethnology Division.

### Job evaluation study for medical profession

At the request of a specialist group of the medical profession, the NIPR investigated the relative difficulty of every procedure (i.e. operations, consultations, etc.) carried out by members of this group, with a view to establishing a rational basis for the fee structure. Although this was the primary aim of the study, it also enabled the NIPR to test the flexibility and adaptability of its job evaluation system in specialized projects of this kind.

The study involved determining the complexity of every procedure carried out by the group, by rating the procedures in terms of specific complexity factors such as theoretical knowledge, manual dexterity, complications, etc.

On the basis of this complexity structure, the relative value (i.e. 'unit' value) for every procedure was determined. These 'unit' values were then tied to monetary values on the basis of a realistic and acceptable income level for the group. To establish this realistic income level, the group was compared with unrelated professional groups functioning on the same complexity level. This part of the project was handled by external consultants in co-operation with the NIPR.

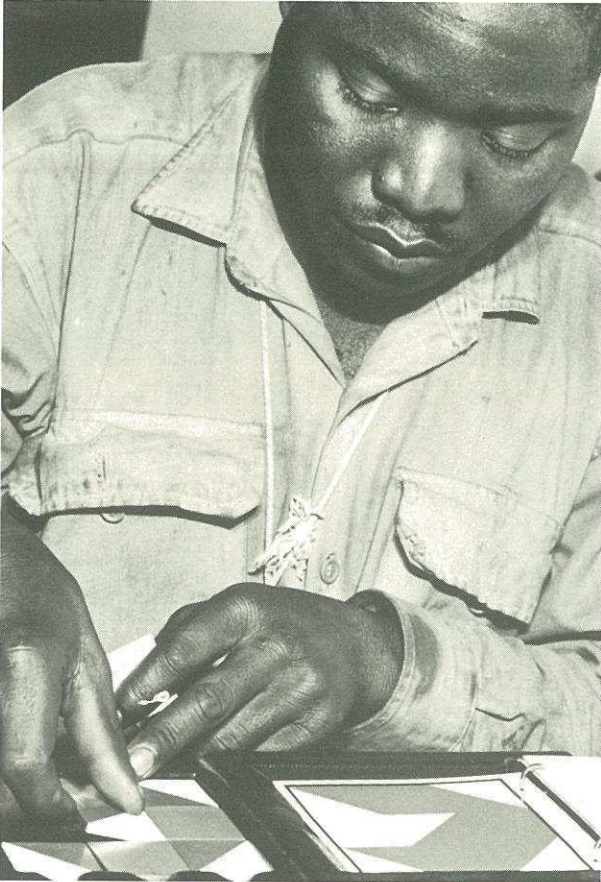
The NIPR job evaluation approach has proved to be capable of adaptation to a professional group not studied before, indicating that similar projects can now be carried out for yet more professions.

### Selection of Non-White operators in clothing industry

The clothing industry is a major employer of Non-White labour in South Africa, but investigations, conducted by the National Productivity Institute (NPI), have shown that its productivity compares unfavourably with similar industries overseas. A study which is being undertaken on behalf of the NPI, aims to improve productivity by improving the selection and placement of Non-White operators, particularly sewing machinists. Attention will also be given to their training.

The NIPR staff-member conducting the study underwent training as a machinist, analysing the job during the process. The criteria to be used in the validation study have been identified





A subject doing a selection test for Black industrial workers.



A study which is being undertaken by the NIPR on behalf of the National Productivity Institute is aimed at improving productivity by improving the selection and placement of Non-White operators in the clothing industry.

and a battery of tests compiled, some being specially designed for this study. Testing of a pilot group on this battery has been completed and the results of the study have proved satisfactory.

This project is particularly important in border industrial areas where labour supply still exceeds demand.

#### **Pedestrians in traffic accidents**

Statistics reveal that a disproportionately high number of Black male pedestrians in the age-range 19 to 45 years are involved in fatal traffic accidents. Statistics also reveal that a high proportion of drivers who are charged with causing the death of these pedestrians are found not guilty and acquitted. It is therefore logical to infer that pedestrians may be held responsible for the majority of these accidents.

Pedestrian culpability has a variety of sources. Among them are: defective judgement of the velocity of an approaching vehicle, poor distance judgement, lack of attention, poor vision, defective hearing, carelessness, bravado, the presence of alcohol or drugs.

The NIPR has decided to investigate the assessment of the velocity of an oncoming vehicle as its first priority. Very little is known about inter-individual and inter-group differences in this particular ability and should the findings suggest a poorly-developed ability in the target population, i.e. Black males aged 19 to 45 years, immediate corrective steps in the form of pedestrian education and road engineering could be taken.

It was furthermore decided that a situation using real-world stimuli would have several advantages over a laboratory-type study and would enhance the validity of the findings. The investigation is therefore being undertaken on the road and, to achieve this, several sophisticated pieces of special equipment have had to be acquired or specially constructed. This phase of the project has been completed and field studies are in progress.

#### **Prediction of manpower needs of a soft-drink manufacturing company**

The Institute was asked by a soft-drink manufacturer to predict, for one of its manufacturing units, manpower needs in five years' and in ten years' time, and to advise on the management systems which would be necessary to cope with these predicted needs.

The project was undertaken in two stages. Firstly, by means of an operational survey, the Company's present situation and its needs with regard to personnel management systems were analysed. Secondly, the Company's planned growth rate was evaluated against that for the industry as a whole and the labour force categorized into 'fixed' and 'variable' components.

It was found that there is a physical limit to the growth of this manufacturing unit and, consequently, a limit to the ultimate size of the labour force which can be employed by it. It was estimated that, at the unit's present rate of growth, this limit will be reached within 3 to 4 years. Changes may, however, be expected in the White-Black employee ratio as well as in the nature of the work performed by the Blacks, particularly in the technical, managerial, supervisory and sales occupations.

Recommendations for meeting needs with regard to manpower management systems were made to the Company.

The above findings are probably applicable to many other manufacturing enterprises.

#### **Guidance, selection and placement of engineers**

The NIPR has been approached by the Federation of Societies of Professional Engineers to undertake a study to improve the





Pedestrians are involved in traffic accidents for various reasons, amongst others defective judgement of the velocity of an approaching vehicle. This apparatus is used in road safety research to determine the ability of pedestrians to estimate the velocity of approaching vehicles.

vocational guidance, selection and placement of engineers in South Africa. Problems exist with regard to obtaining an adequate number of promising university students, their selection to ensure university training success and their effective placement in various fields of specialization. Compared with other industrialized countries, such as the USA and those in Europe, the proportion of the South African population choosing engineering as a career is insufficient for the technological development of the country.

A start has been made with a criterion study involving the job description and evaluation of the various careers in engineering. An attempt will be made to determine the qualities which characterize any specialized field or grouping of the engineering profession, allowing for more specific measurements for the prediction of career success.

The development of a battery of tests for the screening of first-year university students has been completed, and it is at present in use at one university.

#### Training of psychologists

The Institute has been recognized by the South African Medical and Dental Council as an accredited institution for the practical training of industrial, counselling and research psychologists who wish to apply for registration with the Council. When the proposed legislation to control the registration of psychologists other than clinical psychologists is passed, the Institute can expect a marked increase in applications from prospective interns. Two universities have already applied to the NIPR for internship arrangements for counselling psychologists.

#### South African Council for Automation and Computation

A proposal has been received from the South African Council for Automation and Computation (SACAO) for a referral centre to be set up within the NIPR to provide information and advice on the human aspects of the introduction of automation in commerce and industry. This has been agreed to in principle and the feasibility of establishment of the proposed centre is being investigated.

#### Test distribution

There was an increased demand for the training of certain categories of test-users and several courses were conducted in the Witwatersrand area, Durban, Port Elizabeth and Cape Town. 350 new test-users were registered during the year, bringing the total up to 1 300.

A new catalogue was published which includes new additions to the NIPR repertoire.

There was also a marked increase in the demand for tests applicable to Black workers, and test sales again displayed an unanticipated growth. Three times as many tests were sold during the year as three years before.



# textile research

## SOUTH AFRICAN WOOL AND TEXTILE RESEARCH INSTITUTE

Director - DR D P VELDSMAN

**The South African Wool and Textile Research Institute (SAWTRI) undertakes research into the processing characteristics of wool, mohair, cotton, *Phormium tenax* and other plant fibres. An in-depth study is being made of blends of the different natural fibres, especially wool and mohair, wool and cotton, and blends of these natural fibres and synthetic fibres.**

**Much of the Institute's effort is directed towards imparting easy-care properties such as permanent press, shrink resistance, wrinkle resistance and the like to end-commodities. Considerable time is devoted to the improvement of existing processing and testing equipment as well as the development of new equipment and machinery.**

### Cotton processing

An important milestone was reached during the past year when the new cotton processing department was officially opened by the President of the CSIR, Dr C van der Merwe Brink, on May 1st. The commissioning of the cotton plant heralded a new era in the Institute's research which until fairly recently had been concerned only with the natural animal fibres, wool and mohair and their blends. As a national textile research institute the SAWTRI is now fully operative with cotton playing a very important role in its research programme. Close co-operation between the Institute and the entire South African cotton industry has been established and aspects of this industry which are peculiar to the sub-continent are receiving close attention.

The SAWTRI is now responsible for testing various new cotton cultivars for spinning performance so that only the best cultivars may be released for large scale cultivation. Research on behalf of the Department of Agricultural Technical Services is being carried out into the processing differences between mechanically harvested and hand picked cotton.

### Dimensional stability of single jersey knitted fabrics

In the manufacture of single jersey knitted fabric from wool or wool blends, it is important that the end-commodity be dimensionally stable or, in other words, that spiralling and shrinking are minimal when these commodities are washed. The Institute used wool-rich blends of wool and polyester, as well as blends of wool and cotton in equal proportions in an investigation of the possibility of rendering such fabrics dimensionally stable and machine-washable. Wool yarn was shrink-resist treated separately, or the end-commodity from the blend was treated by the application of resin. Machine-washability of single jersey fabrics from wool/polyester blends was achieved by autoclave-decatizing the fabric and applying a polyurethane resin. Autoclave-decatizing the wool/cotton-blend fabric followed by the application of aminoplast resin yielded a fabric of satisfactory machine-washability.

### Relationship between fibre and yarn properties

Textile technologists and textile scientists concerned with research on staple yarns attach great importance to the establishment of precise relationships between the physical properties of the fibres on the one hand, and those of the yarns on the other. These relationships may then be used to establish reference levels (average values) for the various yarn properties which can be used in turn by quality control and research laboratories as a basis for assessing any yarns encountered in practice. Furthermore, it would enable the technologist to predict yarn properties from those of the fibres, and so allow the most economical selection of raw material and yarn characteristics such as linear density and twist with the desired properties.

The Institute's Cotton Processing Division was commissioned during the year. The photographs show equipment in the blow room of the Cotton Processing Division.



The producer seeks answers to questions in connection with fibre fineness, fibre length, and fibre-thickness variation as far as they are concerned with the spinnability of wool and the resultant yarn properties.

Having made an in-depth study of these aspects, the Institute established a series of mathematical relationships between fibre and yarn properties by the application of advanced multiple regression analyses. For this purpose use was made of commercial yarns as well as of some that were spun at the SAWTRI. These relationships now form the basis of a number of reference levels or norms which may be used to predict yarn properties from the known physical properties of the fibre constituting the raw material. The advantages of such norms are obvious and a producer need no longer take unnecessary risks in selecting his raw material for further processing.

#### Physical properties of double jersey wool fabrics

The establishment of reference norms for certain double jersey wool fabrics is needed in the same way as for fibre properties related to yarn properties (discussed in the previous paragraph). This need stems from the question whether a certain fabric, whether knitted or woven, is acceptable as far as a particular physical property (abrasion resistance, pilling, air permeability, etc.) is concerned.

If data were available about minimum levels of the various physical properties of the fabrics which are required for satisfactory performance during wear, it would be possible to establish reference norms for the accurate assessment of fabrics. Because of a dearth of such information in the literature, the SAWTRI decided to measure the physical properties (notably abrasion resistance, air permeability, drape, stiffness and bursting strength) of a range of all-wool double jersey fabrics as well as some wool blend fabrics to establish average or expected reference levels for the various properties.

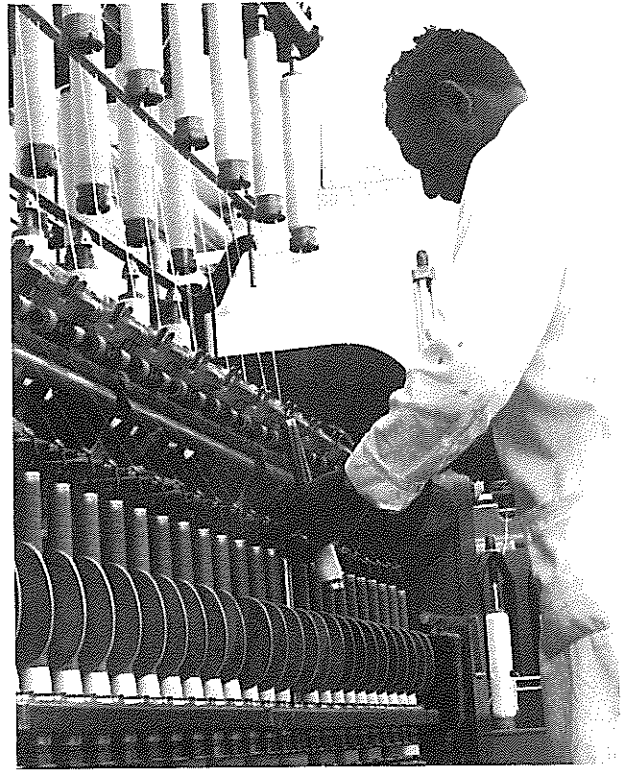
Preliminary results on a total of 80 fabrics, of which 70 were of pure wool and 10 of wool/synthetic blends, have already been obtained and a number of graphs have been prepared which reflect the relationship between the fabric properties and the fabric mass per unit area. These graphs can be used to assess the performance of double jersey fabrics similar to those measured during the investigation into these properties.

#### Unconventional method of manufacturing mohair blankets

A new approach to the manufacture of mohair blankets at the SAWTRI indicates that blankets from this speciality fibre, usually regarded as very expensive, may now be within reach of more consumers and at a relatively reasonable price. Mohair blankets are traditionally woven from loop yarns on a type of machine that is rather slow in operation. This extended production time factor makes the process costly, adding to the high price of the end-commodity.

By employing a modified Raschel warp-knitting machine equipped with carbine needles a very acceptable blanket was made. Although the use of carbine needles requires more complicated designing and a more critical setting of the front guide bar, the advantages completely overshadow the disadvantages. Because the carbine needle is exceptionally sturdy and can handle the coarse mohair loop yarns with ease, there were no needle breakages. Carbine needles have no latch or open end for fibres to catch on, which in itself is an advantage. The use of carbine needles makes higher machine speeds possible and the fault rate is much lower than with conventional machines.

A further economic advantage of the new method is the use of a pillar stitch yarn containing 50 per cent cotton and 50 per cent polyester which is much cheaper than mohair yarn. A production rate of 20 m/h and an eventual fabric mass per unit area of approximately 370 g/m<sup>2</sup>, as well as the almost unlimited design potential are all possible through this new approach which may well prove to be attractive to manufacturers of mohair blankets.



Yarn being spun in the Cotton Processing Division.

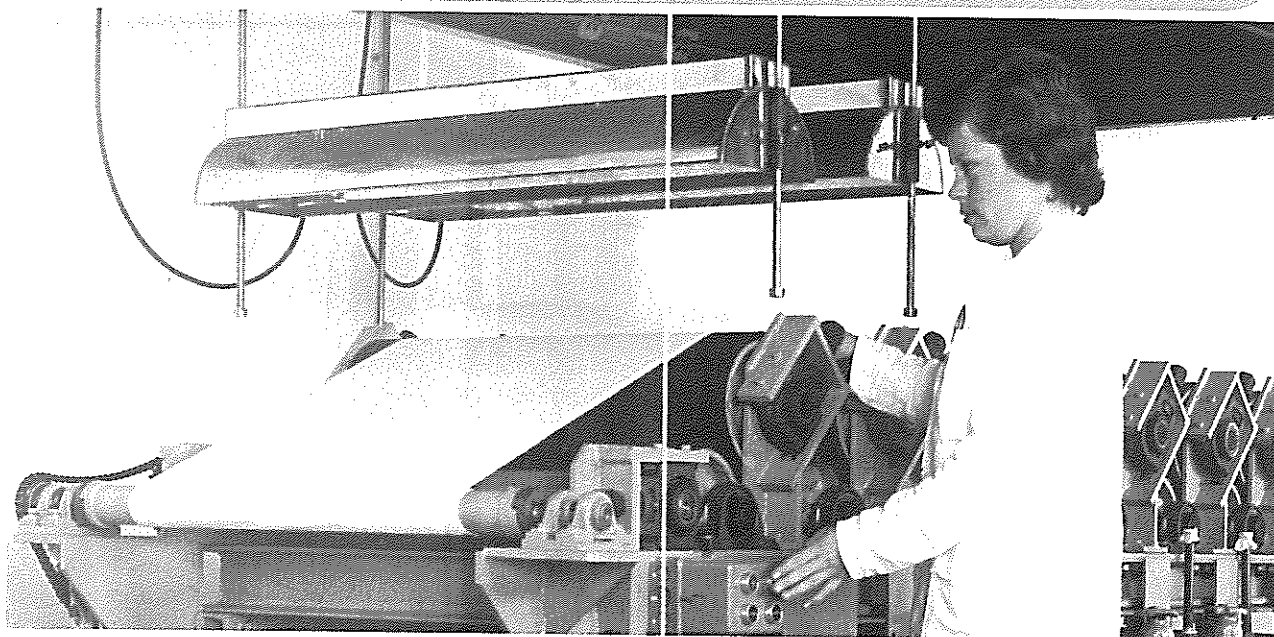
#### Processing of wool/cotton blends on the worsted system

Wool and cotton have been used in blends for the manufacture of fine fabrics for shirting and other garments for a considerable time. Processing of the blend components have, however, been carried out almost exclusively on either the cotton system or woollen system which do not require the fibres to be combed before yarn is spun. For a blend of cotton and wool to be utilized to the fullest extent, i.e. to produce a good quality yarn, the blend must be as intimate as possible. The most popular method of producing wool/cotton blends on the cotton system currently involves the use of wool tops or specially prepared worsted slivers ('broken' and 'open' slivers). The wool component is introduced together with the cotton component at the drawframe stage of the cotton system prior to roving and spinning. This type of blending, however, cannot be regarded as being as intimate as when a carding machine is used.

Worsted combers are becoming interested in blending wool with cotton since it is known that production on the worsted system yields a particularly sleek and superior yarn. With this in mind the SAWTRI commenced with a project involving the processing of cotton/wool blends on the worsted system. Briefly, this entailed hand-blending cotton lint (Acala 442 cultivar) and scoured wool (6 to 7 months spinners style 64's); carding on a worsted card; fibre-straightening on a gill box and rectilinear combing to produce a combed blend top and finally spinning into yarn.



This machine for liquid ammonia mercerising of cotton fabrics was built by the Institute.



It has already become clear that 50/50 blends of cotton and wool can be processed successfully on the worsted system up to the top stage at production rates of 50 to 60 per cent of that of wool, only 4 to 5 per cent of the cotton being combed out as noil. The yarn produced contained approximately 45 per cent cotton and 55 per cent wool. There were very few end breaks and the yarn produced had a good appearance, similar to that of a Class A cotton yarn. The irregularity was higher than that of average pure cotton yarn or average pure worsted yarn but was the same as that from short stapled wool previously spun on the same machinery. The breaking strength of the yarn was superior to that of a normal worsted yarn but the extension at break was considerably lower.

The investigation is by no means completed as yet but worsted processing of wool/cotton blends seems to hold great promise.

#### Development of small decorticator for phormium leaves

The phormium plant (*Phormium tenax*), also known as New Zealand flax, provides fibres for certain textile purposes such as a substitute for jute in the manufacture of grain bags and similar containers. The phormium industry has been established mainly in the Bantu homelands where both large-scale and small-scale phormium farming is in progress.

The leaves from the plant are cut and have to be decorticated to provide the fibres for textile processing. Although the Corona decortivating machine is used on large estates, there has been a need for a smaller machine for use on the smaller farms. Such a machine has now been developed by the SAWTRI. The new machine is a considerable improvement on those currently in use, having a much better discharge of fibre. This has resulted in labour saving in the transfer of fibre from the machine to the next processing stage. It is also much more robust and is easier to maintain, thus making it more economical to operate.

The prototype machine is now being used for routine fibre production on the Ndaleni farm of the Kwazulu Government Service, near Richmond.

Proper washing of decorticated fibre produced by a small machine has always been a problem. The SAWTRI has now also developed a continuous washing system; the decorticated fibres are transported along a continuous rope which passes very close to a rotating drum of open mesh wire. The fibres, hanging from the rope, when passing the drum, are washed by powerful jets of water directed at the drum surface. In this manner the fibres are held fast while most of the impurities are removed.

# geomagnetism

## MAGNETIC OBSERVATORY

Head - A M VAN WIJK

Since the advent of the space age, a picture has emerged in which the geomagnetic field is seen as a complex feature of our planet interacting with its environment in the solar system. The generating processes take place either deep in the Earth or high in space. In situ measurements in space as well as ground-based observations are required for studies of the complex processes occurring in the Earth's environment. The Magnetic Observatory at Hermanus, CP, is one of the worldwide network of geophysical institutions responsible for the ground-based observations and other space-related activities.

The functions and current programme of the

Magnetic Observatory include the continuous monitoring of geomagnetic and related geophysical elements, the determination of the configuration and variations of the magnetic field in Southern Africa, the maintenance of magnetic standards, the analysis and dissemination of the data, and co-operation in both national and international geophysical programmes. Although the activities of the Observatory have, by their very nature, an international character, due attention is given to the needs of local research workers and national organizations. The Observatory's own research programme is concerned mainly with the analysis and interpretation of time variations in the geophysical elements.

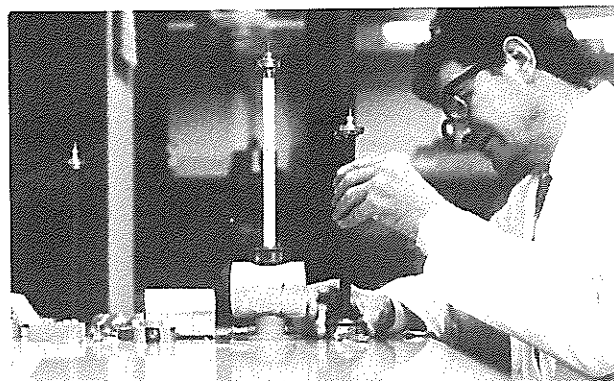
### Geomagnetism

The Observatory's geomagnetic monitoring programme provides a continuous record of the variations in the Earth's magnetic field at four widely-separated localities in Southern Africa. The recording stations are located at the Observatory's headquarters at Hermanus, at Tsumeb in South West Africa, at Hartebeesthoek in the Transvaal and at Grahamstown in the Eastern Cape. The 'MOCSIR' digital magnetometers currently in operation at Hermanus, Hartebeesthoek and Grahamstown were developed and constructed at the Hermanus Observatory.

Auxiliary magnetic equipment at Hermanus includes a variety of 'absolute' magnetometers as well as a special induction magnetometer for recording magnetic pulsations in the frequency range 0,2 to 0,003 Hz. The pulsations are reported in the Observatory's monthly magnetic bulletin. Also included in the bulletin are the Hermanus K indices of magnetic activity and the onset times of sudden storm commencements (ssc's), sudden impulses, solar flare effects and magnetic 'bays'.

The secular changes in the geomagnetic field necessitate periodic revision and updating of magnetic charts. As these changes in Southern Africa are among the most rapid in the world, the Observatory conducts secular variation surveys — also known as 'repeat' surveys — at intervals of about five years. During the past thirty years, the Observatory has taken the initiative in promoting co-operation with its counterparts in neighbouring territories, in synchronizing the secular variation surveys in Southern Africa, and in compiling regional magnetic charts.

Towards the end of 1973 the Observatory decided at short notice to carry out the next full-scale secular variation survey of the Republic in 1974 — a year earlier than originally planned. The decision followed a request from the International Association of Geomagnetism and Aeronomy that up-to-date observatory and field data be made available by 1 January 1975 for



A senior technician at the Observatory assembles a field declinometer of his own design.

use in the compilation of the new International Geomagnetic Reference Field (IGRF 1975,0). Besides re-occupying most of the 60 'repeat stations' in the Republic and South West Africa, the Observatory assisted the Geological Survey of Botswana in establishing four secular variation stations in that country. The assistance given to the Department of Surveys of Rhodesia in connection with the magnetic survey concurrently conducted in that country included the calibration of magnetometers and the loan of supplementary field equipment.

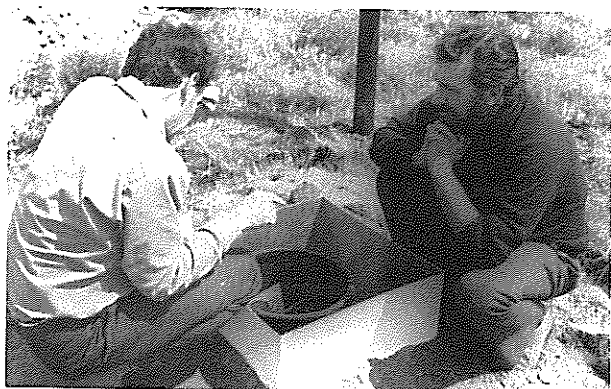


Research conducted at the Observatory during 1974 included power spectrum analyses of a variety of geophysical and solar-terrestrial time series. Among the results which attracted considerable attention were the detection of the 'Pacific Region Anomaly' in the geomagnetic spectrum at  $\sim 60$  years, and evidence for a signal at 10,5 years in the spectra of global surface air temperature data from weather stations. The latter finding is believed to be the best evidence thus far presented that solar activity does indeed modulate weather at the Earth's surface to a measurable degree. As a result of these and other findings reported by the Observatory during the past few years, numerous requests have been received from South African and overseas scientists for information on the 'maximum entropy' power spectrum technique used at Hermanus.

#### Cosmic rays

Operation of the Chalk River type 12-NM-64 neutron monitor at Hermanus continued throughout the year. The average counting rate of this 'supermonitor' showed the expected increase with decreasing solar activity and is expected to reach a maximum during the 1975-76 'low' in the current 11-year sunspot cycle. Despite the decline in solar (and geomagnetic) activity, a considerable number of transient ('Forbush') decreases in cosmic ray intensity were recorded during 1974.

The cosmic ray programme at Hermanus is conducted in cooperation with the CSIR Cosmic Ray Research Unit centred at the Potchefstroom University. The routine data recorded at Hermanus are processed on the computer in Potchefstroom and published by the Observatory.



Scientists discuss the orientation of a newly-installed digital magnetometer at Grahamstown. The Observatory's geomagnetic monitoring programme provides a continuous record of the variations in the Earth's magnetic field at four widely-separated localities in Southern Africa.

#### Ionospheric observations

The ionospheric monitoring programme outlined in the 1973 Annual Report continued without change. The continuous recordings of VLF atmospherics at 27 kHz and of cosmic radio noise at 30 MHz once more provided immediate confirmation of suspected geomagnetic SFE's (solar flare effects).

Special investigations initiated during the year included an examination of the 30 MHz riometer records for evidence of

ionospheric absorption effects due to electron drift across the South Atlantic Geomagnetic Anomaly.

The Observatory operates a Wadley ionosonde for the National Institute for Telecommunications Research (NITR). The data are processed at the NITR in Johannesburg and published in its *Monthly bulletin of ionospheric characteristics*.

#### Geophysical alerts

Geophysical research units and other interested organizations in the Republic are advised of the onset of magnetic and ionospheric disturbances with the minimum of delay. The messages are relayed through the communications network of the Weather Bureau.

#### Magnetic activity indices

The Observatory is one of the few magnetic stations whose data have been selected for use in the determination of the 'planetary' indices of magnetic activity, Dst and Ks. The monthly tabulations of Hermanus data are supplied to the relevant international centres as soon as possible after processing.

#### Antarctic research

The Observatory provides laboratory and other facilities for the geophysicist from Potchefstroom University who organizes the Antarctic programmes for geomagnetism and aurora. The geophysicist is stationed at Hermanus and is assisted on a full-time basis by a research officer of the Observatory.

#### Antarctic research

The observational programme conducted by this group comprises the continuous recording of the geomagnetic elements at Sanae and on Marion Island, and an extended programme of auroral observations at Sanae. The observation of auroral pulsations around 4278 Å in the N<sub>2</sub> band was continued and a start was made with the observation of proton aurora (Hβ).

Research conducted by this group during the past two years included a study of Pi2-type magnetic pulsations and an analysis of the geomagnetic quiet-day (Sq) variation at Sanae.

# timber research

## TIMBER RESEARCH UNIT

Head - DR D L BOSMAN

The Timber Research Unit (TRU) was established to serve the needs of the wood and wood products sector and the pulp and paper sector of the Republic's forest products industry. As a multidisciplinary, industrially oriented organization, the Unit offers a wide variety of specialized research services to both producers and consumers of forest products. Research and development in timber technology are managed on business principles and the research process is carried beyond the development stage into the field of practical application.

The Unit consists of divisions for timber engineering, wood processing, pulp and paper, timber economics, special projects, and information and liaison services. The aims of the TRU are:

- the effective utilization of South African timber resources
- the development of satisfactory woodbase products
- the development and improvement of manufacturing processes
- the effective use of timber products.

### International forestry meeting

A highlight of the year's activities was the first meeting on South African soil of Division 5 (Forest Products) of the International Union of Forestry Research Organizations (IUFRO) which was attended by leading wood scientists and technologists from 22 countries. The meeting, acclaimed a great success, was the culmination of months of preparation by the organizing committee on which the TRU was represented.

The meeting was held in Cape Town, Stellenbosch and Pretoria and the theme was 'Wood in the service of man'. Eighteen per cent of the 140 technical papers were by South Africans and one in eight were contributed by the TRU.

The publication of the proceedings of the meeting was undertaken by the TRU.

### Documentation service

The TRU recently introduced a literature scanning service, Abstracts Information Distribution Service (AIDS), for the benefit of the timber industry. Current articles on the latest developments are abstracted each month from numerous periodicals and brochures and published in a review list. Photocopies of the articles reviewed are available to all research sponsors and subscribers to AIDS.

The feasibility of linking this service to SDI (Selective Dissemination of Information) services, which are computer-based, is being investigated.

### Industrial training

A short course was held for middle and senior executives, engineers, architects, woodwork teachers and others whose work demands a knowledge of timber technology. The programme aimed to bring together people from different parts of the industry in a lively yet relaxed atmosphere of informal training.

A well-attended seminar on sawmill management was arranged by the TRU and the Industrial Research and Development Group of the CSIR for senior executives in the sawmilling industry. These courses will feature regularly in the annual programme if they continue to prove popular.

In conjunction with the Department of Forestry and other interested bodies, the Unit has been investigating the possibility of establishing a timber technology course at colleges for advanced technical education.



### Liaison with industry

Pursuing the policy of devoting more time to liaison with the timber industry in the form of personal visits to firms and individuals, the head of the Information and Liaison Division called on timber processors in Natal and in the south-eastern and eastern Transvaal, special attention being paid to those mills with which there has been little or no contact in the past.

The visits were used to publicize and explain the work of the TRU, to identify problems needing attention and to encourage industrialists to make greater use of the facilities of the Unit. Attention was drawn to the timber technology courses offered by the Unit and to the TRU Research Participation, Sawmilling Research Sponsorship and Subscription Services schemes.

### Stress grading

The use of mechanically stress-graded timber became entrenched during 1973. There is no longer any doubt that markets for mechanically stress-graded timber will continue to expand rapidly in the future.

The main market for stress-graded timber is for the manufacture of prefabricated roof trusses where 15 fabricators have TRU Timber Graders in regular use.

Analytical models were developed to predict the strength and stiffness of finished laminated beams when the stiffness of the raw material is known. Tests have been completed to provide data necessary to extend the models to beams with different numbers of laminations.

It has also been shown that beams of a required minimum working stress can be manufactured with much less graded timber if the latter is mechanically graded according to stiffness than if it has been graded visually using existing grades. This approach has been accepted by several manufacturers of stock glulam who have bought TRU Timber Graders and have introduced them into the production line of their plants.

### Roof truss designs

Standard designs for W-trusses with nailed plywood gussets have been completed and are available with a range in pitch from 17,5 degrees to 35 degrees and spans up to 10,6 metres. These designs are for tiled roofs and should the demand warrant it a further series will be produced for corrugated iron roofs.

### Wood adhesives

A substitute for resorcinol-based adhesives used in manufacturing glulam beams was urgently required on account of the acute shortage of resorcinol which arose in South Africa towards the end of 1973 and which is likely to continue indefinitely. Tests at the TRU showed that medium hot-setting adhesives of the phenol and wattle tannin types are suitable for this purpose provided the beams are sufficiently heated during the curing stage in lamination and that the beams do not dry out during curing.

### Timber drying

Experiments at a State sawmill and a private sawmill showed that the revenue from sawn timber can be increased substantially by the decrease in warp achieved through the weighting of stacks during kilndrying.

A system of self-weighting whereby timber less prone to warp is placed at the top of stacks appeared to be a practical method for use by the industry.

Two new projects, one on pole drying and the other on kiln design and performance requirements, were started.

### Veneer lamination

Laboratory and pilot plant scale experiments showed that the yield of structural timber obtained by means of veneer peeling and lamination (veneerlam) is not as high as could be expected, because of log imperfections, but that the strength of the timber is nearly doubled.

An economic assessment indicated veneerlam production to be more profitable than sawmilling or the manufacture of stock glulam. A suitable process for the commercial production of veneerlam is being developed.

### Pine bark

Chemical analysis showed that the bark of *Pinus patula* contains about 2 per cent fats, waxes and oils and 20 to 30 per cent of tannins.

### Timber trend analysis

A timber trend analysis which is being conducted is aimed at detecting discrepancies between supply and demand at an early stage. It is intended that the information obtained should be used for short-term supply/demand forecasting and for designing effective measures to overcome the problems of shortages and oversupply within the industry.

Four quarterly bulletins were published and distributed to 150 sawmillers, 500 users of sawn timber and other interested parties.

### Furniture

Results obtained from an in-depth analysis of the furniture industry show that the yearly South African pine intake for furniture manufacturing is approximately 92 000 m<sup>3</sup>. Consumption of all other timber for furniture is approximately 173 000 m<sup>3</sup>.

The expected growth rate for South African pine in furniture manufacturing is estimated at 15 per cent per annum. The expected growth rate for all other timber is estimated at 10 per cent per annum.

A suitable process for the commercial production of veneerlam is being developed. An economic assessment indicated veneerlam production to be more profitable than sawmilling or the manufacture of stock-glulam.



### Supply and demand of roundwood

A study to update a demand prognosis published in 1968 and to investigate the roundwood supply position in South Africa was completed.

The study showed that a serious situation of undersupply could develop within the next ten to fifteen years for both coniferous and non-coniferous species. In order to satisfy the demand for roundwood by the year 2000 the present area under plantation will have to be more than doubled.

The total consumption of timber in 1972 was estimated at 13,7 million cubic metres roundwood equivalent. The annual growth rate was estimated at 4,0 per cent per annum.

It is expected that the relative importance of coniferous timber will increase from the present 47 per cent of total consumption to 59 per cent by the year 2000.

The pulp and paper industry is at present the largest single consumer of roundwood with 27 per cent of total consumption. It is expected that this will increase to 49 per cent by the year 2000.

### Waste paper recovery

Waste paper is an important substitute for timber which is used as pulpwood in the manufacture of paper and paperboard. Because timber is expected to become scarcer in the future, greater importance will be attached to substitutes such as waste paper.

The TRU has undertaken a study of the collection and grading of waste paper as it is applied in South Africa. The dearth of basic statistics on these activities necessitated the gathering of statistical data before any prognostic study could be made of the future supply and demand of waste paper.

The important aspect was the determination of the economic quantities that are available, especially as the costs of waste paper recovery are very sensitive to transport cost and labour cost increases.

### Sugar-cane bagasse

The pulping and papermaking potential of local sugar-cane bagasse is being assessed and basic information collected on its use for these purposes.

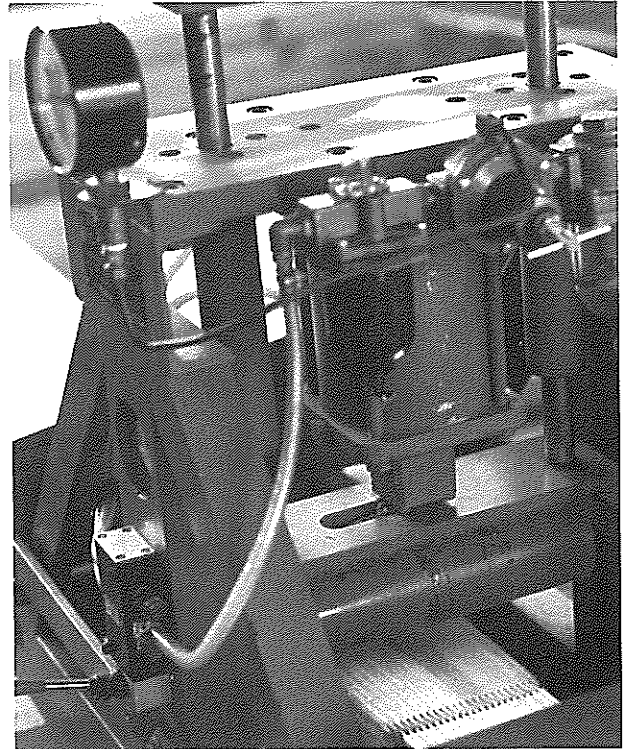
The experimental work in an investigation into the efficiency of various methods of storing bagasse on a plant scale prior to pulping was completed. The storage methods compared in the first phase of this work were based on the Ritter process, treatment with mill effluent and treatment with an organic acid.

The second phase of the investigation involves a comparison between the response to storage of mill bagasse and diffuser bagasse. The storage method employed is based on pH control.

Research was also carried out to establish the influence of various prehydrolyzing conditions on the suitability of bagasse for further processing into dissolving pulp. The work included pulping and bleaching of the prehydrolyzed bagasse.

### Aging and preservation of paper

It was found that the aging rate of paper increases with increasing temperature, percentage relative humidity of the aging atmosphere and acid content of the paper. In addition the above-mentioned three factors interact positively with each other during paper aging, i.e. the combined effect of these three independent aging factors is greater than the sum total of the individual influences. However, it was not possible to describe the influences of the aging factors quantitatively from the data obtained.



It has been shown that laminated beams of a required minimum working stress can be manufactured with much less graded timber if the latter is mechanically graded according to stiffness than if it has been graded visually using existing grades. This approach has been accepted by several manufacturers of stock-glulam.

### Physical and chemical requirements of pulpwood

During the past few years twenty pine samples representing a wide range of physical and chemical properties have been pulped and the wood, fibre and chemical properties determined. The object of this investigation was to describe pulp properties in terms of wood properties by means of regression equations. The work will assist the Department of Forestry in developing a breeding programme for pulpwood trees.

A study was completed of the geographic variation in the properties of *Eucalyptus grandis* grown in South Africa and of the wood and fibre properties which have the greatest influence on the strength and surface characteristics of paper.

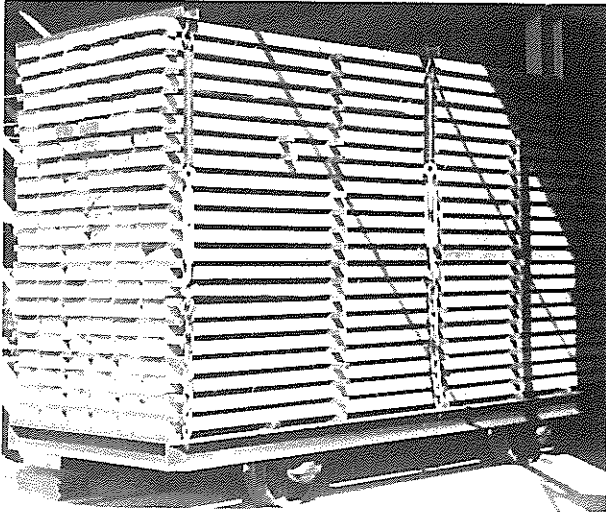
### Stock glulam

The TRU carried out extensive experiments on the effect of important raw material properties on the strength properties of stock glulam.

It has been found that by using specific stress grades for the outer laminations and lowest grade material for the inner laminations, re-sawable stock glulam beams with an assured working stress in bending of 6 MPa can be produced. These research results will be incorporated in an SABS standard specification for stock glulam.

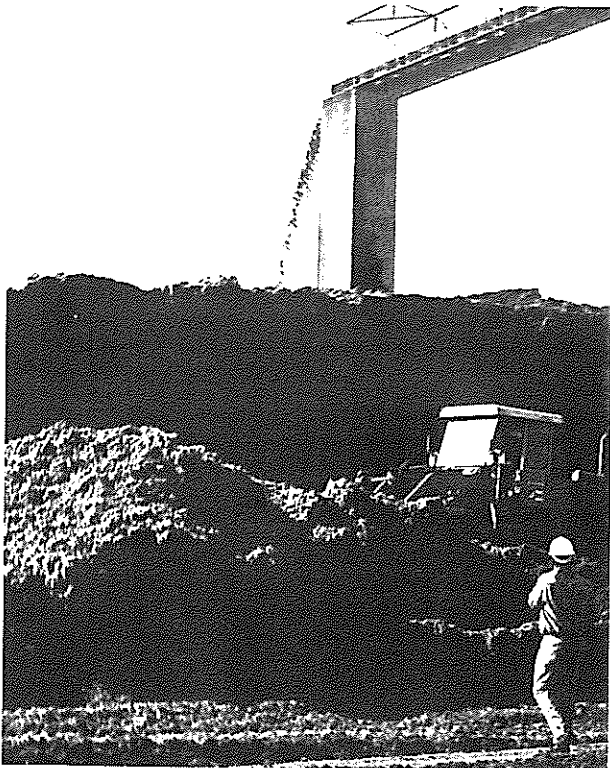
An interfirm comparison, which encourages participants to keep records of production, stock, yields, recovery, etc. and enables them to identify areas where performance lags behind self-set





Experiments at sawmills showed that the revenue from sawn timber can be increased substantially by the decrease in warp achieved through the weighting of stacks during kiln-drying.

The TRU is assessing the pulping and papermaking potential of local sugar-cane bagasse and is collecting information on its use for these purposes. The experimental work in an investigation into the efficiency of various methods of storing bagasse on a plant scale prior to pulping was completed.



or accepted standards, was continued on a monthly return basis.

An in-factory quality assurance test of finger-jointed timber used in the manufacture of stock glulam was developed and applied.

#### Production control in sawmills .

A series of projects have been initiated which together will provide the sawmilling industry with a production and cost control system.

A machine capable of measuring wet mill output on a continuous basis is being developed and the first production prototype was installed in a sawmill in 1974.

Timber recovery has been shown to be substantially increased (by up to 10 per cent) by exercising dimensional control using existing sawmilling machines.

An operations research model and a computer program for the development of sawing patterns has been completed for idealized cylindrical logs. This programme will be expanded to include taper and possibly log crook to improve the accuracy of simulation. The patterns will enable sawmillers to better match available logs with market demands for saw timber and to increase the economic and volumetric recoveries from roundwood.

# chemical engineering

## CHEMICAL ENGINEERING RESEARCH GROUP

Head - W G B MANDERSLOOT

Chemical engineering deals with the processes and operations by which the properties or composition of matter in bulk are changed. Thus the activities of the Chemical Engineering Research Group (CERG) cover not only the needs of the chemical industry but also many processing aspects in the petroleum, petrochemical, mineral, food, beverage, biochemical, pharmaceutical, ceramic, paper and textile industries, and in environmental technology (in which water, effluents and air are important). The interdisciplinary nature of chemical engineering provides a useful link in carrying out tasks undertaken in close co-operation with other institutes and organizations.

The research and development items on the Group's programme are selected according to the immediate and anticipated needs of industry. The Group provides a wide range of consulting services to industry. If necessary these services are backed up by applied research.

### Services to industry

The Group's semi-technical scale equipment for drying, mixing, extracting, etc. is available to industry for long-term and short-term investigations. This service meets the needs particularly of the smaller industries which do not have their own research and development facilities.

On request advice and information is given on solving certain processing and related problems encountered by industry. The Group is collaborating with the National Electrical Engineering Research Institute in an investigation on the modelling and optimization of sugar milling operations. Another investigation was concerned with the myth of 'rejuvenating additives' for lead-acid batteries.

The Group also maintains a well-equipped laboratory for particle size analysis. The analysis of samples submitted by industry often leads to further advice on related process problems.

Another service provided by the Group is the evaluation of manganese dioxide for utilization in the manufacture of small batteries (dry cells).

Considerable demand was experienced for all these services over the year.

### Prevention of air pollution

The process industry's measures for preventing air pollution are often based on emission measurements. Sampling of stack gas

is carried out at the request of industry. In the course of the year emissions were measured at a foundry, power station, paper mill and steel works and advice on emission control was given to various industries. A brochure was issued which summarizes the points to be considered in emission sampling and the bibliography on the subject was updated.

The CERG sampling staff also assisted in the training of an outside sampling team. When required sampling equipment is manufactured for industry at cost. Thus two sets of sampling equipment were supplied and detailed information given to several enquirers on the selection of sampling equipment.

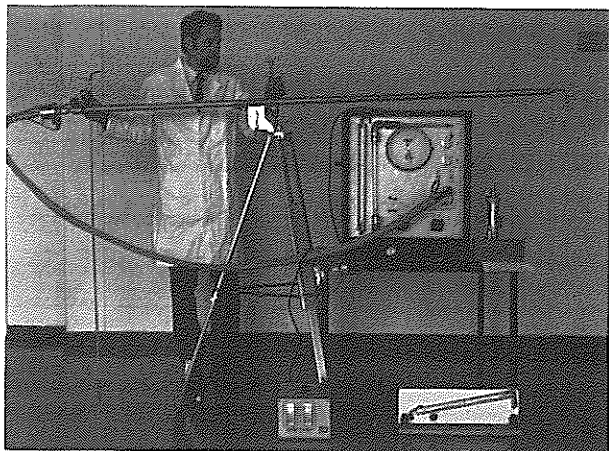
Comprehensive scanning and indexing of the technical literature relating to all aspects of pollution control likely to be encountered in this country has provided an extensive 'library' of control measures and techniques. Industry and control authorities are invited to utilize this source of information through which full use can be made of air pollution control experience elsewhere.

Wet bulb psychrometry in flue gas was reviewed critically in terms of fundamental considerations with a view to the determination of humidities in gaseous emissions. A computer program was developed for the processing of readings taken in wet flue gases.

### Computer programming

In an environment with limited trained manpower certain repetitive tasks should be taken over by the computer. The





Equipment for the testing of dust emissions as supplied to industry. When required sampling equipment is manufactured for industry at cost.

development of the required computer programs has become an important function of the Group; these programs are made available to industry.

The checking of data to be fed to a computer is facilitated by labelling the data with a keyword, e.g. the name of the variable involved. A FORTRAN subroutine was developed for reading keyword-labelled data in random order and when using an IBM version of FORTRAN IV the data may be presented in free format.

#### Heat exchangers

The Group provides a service to industry on design and evaluation of heat exchangers. To promote the saving of cooling water the accent of the work is on air-cooled heat exchangers.

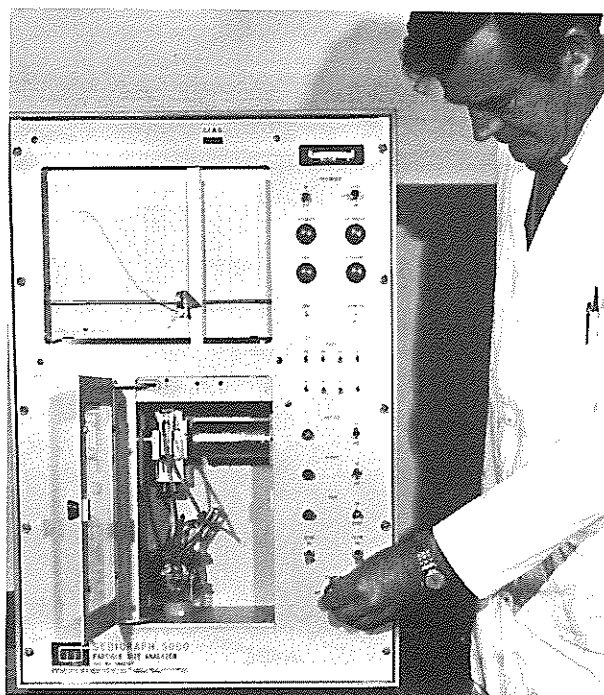
The design and rating service makes use of computer programs for cost-optimized design and for performance evaluation. The computer programs are either developed by the Group or obtained elsewhere, e.g. from the Heat Transfer and Fluid Flow Service of AERE at Harwell, UK, with which close co-operation has been established.

The development of computer design programs is backed up by theoretical investigations aimed at improvements in programed design and by experimental investigations in fields where insufficient design information is available.

The range of available programs was further extended to cover more cases encountered in the process industry. Based on theoretical work it was possible to derive improved designs for steam-heated fast-rotating paper-drying drums. A brochure was issued which comprehensively describes the service offered by the Group in the field of heat transfer.

#### Flow in manifolds

Manifolds are widely used in the process industry to distribute fluids and gases but very little design information is available; this information is now being collected experimentally. Previous investigations on the pressure and flow distribution at a single junction in a pipe manifold were complemented by experimental work on the interaction of adjacent laterals.



One of the instruments used in the determination of particle size. The GERG maintains a well-equipped laboratory for particle size analysis. The analysis of samples submitted by industry often leads to further advice on related process problems.

#### Filtration of mineral slurries

In the extraction of uranium from acid-leached gold ore the filtration step is an important cost item. Previous work in this line was rounded off and a summary of the work carried out in this field was presented at an international filtration conference in Paris (May 1974). The main conclusion was that by changing the conditions of operation it is possible to decrease the number of filters required for a certain duty.

Pilot scale work at a full scale plant proved to be a powerful technique to obtain reliable results and it allows costly full-scale experimentation to be limited to confirmation runs under the optimum conditions derived from controlled pilot scale experiments.

# air pollution

## AIR POLLUTION RESEARCH GROUP

Head - DR E C HALLIDAY

The Air Pollution Research Group is mainly concerned with the chemical nature and the abundance of pollutants in the atmosphere, and with the physical behaviour of these pollutants from the time they are emitted until they are deposited or absorbed on the ground. These studies have considerable application to current problems of pollution control.

### Diffusion of pollutants

With the return of a senior staff member from a one-year study period in Europe, work has recommenced on the theory of the transport and diffusion of pollutants in the atmosphere. Measurements of the spectrum of turbulence (the frequency of occurrence of eddies with different times of duration) are in progress. All equations which attempt to provide quantitative estimates of the degree of dilution of a pollutant during its travel through the atmosphere must include parameters related to the eddy spectrum, while predictions of the height to which a plume of hot gases will rise in the atmosphere involve a knowledge of the magnitude of the long period eddies produced by thermal convection. This project is of obvious interest to industry and it is being supported by four large industrial organizations as well as by the Department of Planning.

### National survey of smoke and sulphur dioxide

The number of local authorities which are now co-operating in the national survey of smoke has risen to fourteen, seven of which are monitoring sulphur dioxide. A CSIR publication *Statistics on smoke and sulphur dioxide pollution in South Africa* shows that over the years 1962 to 1972 seven out of twenty-one measuring sites showed a decrease in sulphur dioxide, three showed an increase and eleven showed no significant change. In the case of smoke, fifteen sites showed a downward trend, four an upward trend and twelve showed no significant change. It can therefore be concluded that the problem of smoke and sulphur dioxide in South African cities is not worsening.

### Pollutants from street traffic

The programme of measurements of carbon monoxide, oxides of nitrogen, hydrocarbons and oxidants has reached the stage where the values for 1968, 1971 and 1973 can be compared.

The measurements were made in Pretoria, Johannesburg and Durban and the measuring sites were unchanged from year to year. In addition in each city the measurements were made during the same season so that effects due to atmospheric stability changes would be minimal.

The study has revealed no startling changes in the quantity of any of the materials studied.

### Ventilation potential of a geographical region

This investigation is a direct application of the results of research on the diffusion of pollutants (see paragraph above).



A mobile laboratory used by the APRG to measure pollutants in the atmosphere. On the left a sample of air is collected in a special container for analysis. On the right particulate material is collected in an electrostatic precipitator.

During the whole of 1973 the Air Pollution Research Group co-operated with the Weather Bureau, a department of ISCOR and the Department of Health, to make an extensive study of the atmosphere over a geographical region, inland from Saldanha Bay. This area of nearly 900 km<sup>2</sup> is scheduled for intensive general development following on the establishment of an iron ore loading facility and an ore smelter by ISCOR.

The Air Pollution Research Group contributed equipment for measuring wind speed and direction and for measuring atmospheric stability (temperature gradient in the vertical direction), the Weather Bureau contributed further equipment for wind measurements (eight sites were instrumented) and the four co-operating bodies formed a study committee. The study involved the analysing of over 120 000 wind measurements and 20 000 temperature measurements.

The final output was a map showing areas suitable for industrial use, areas suitable for residential development, areas suitable for recreational use and areas which should be buffer zones.



# technical services

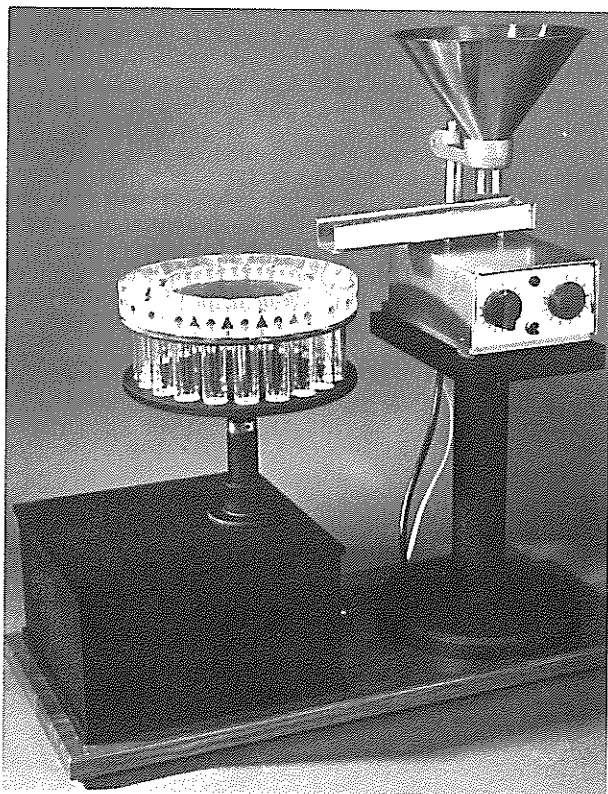
## TECHNICAL SERVICES DEPARTMENT

Director - T HODGSON

The Technical Services Department (TSD) designs and manufactures research equipment and renders essential services such as graphic arts, transport and stores to the national laboratories and institutes of the CSIR.

The Department also undertakes work on contract for other bodies and industry if the work

cannot be done anywhere else in the Republic. This service includes advice on the optimization of machining and manufacturing techniques. The Department maintains close liaison with overseas bodies that are active in this field, such as the Production Engineering Research Association (PERA) in the UK, to avoid duplication of effort.



The Technical Services Department assists the CSIR's research institutes with the design and manufacture of various items of specialized equipment such as this rotating sample divider.

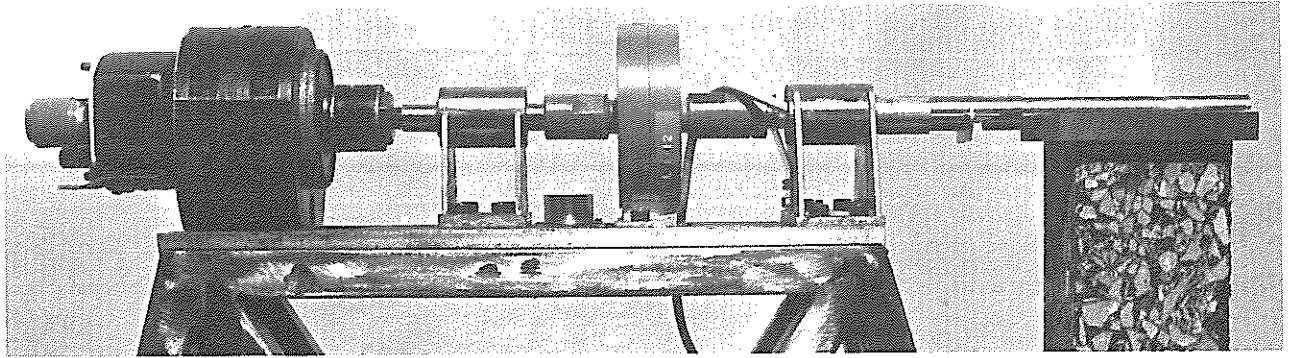
### Services to the CSIR

The Technical Services Department assisted the CSIR's research institutes with the design and/or manufacture of various items of specialized equipment, a few of which are mentioned below:

- rotating sample divider
- hydroclone for an apparatus used for the measuring of liquid velocity by means of a laser beam
- apparatus for measuring pollutants in smoke stacks
- deep sounding device for measuring the shear strength and compressibility of subsoils *in situ*
- modifications to equipment for measuring the co-efficient of friction in road surfaces
- triaxial cell for the measurement of deformations of bitumen-bound road samples under pressure
- device for measuring length and thickness of sawn timber during production at sawmills
- magnetic variometers for basic geophysical research
- shear box for the determination of shear strength in joints of rock masses
- torque-limiting device for the calibration of slip-clutches
- water gas target for production of fluorine 18
- argon target for production of potassium 43

### Training of instrument makers

The rapidly growing demand for technical staff, especially in the manufacturing industry where extensive use is made of the abilities of qualified instrument makers, requires an urgent increase in the number of persons trained by the Technical Services Department for this purpose.



This apparatus for the measurement of deformations of bitumen-bound road samples under pressure was manufactured for a research institute of the CSIR.

#### **Investigation, advice and development**

Assistance rendered to industry on a contract basis included the following:

- investigation into the designing of a debarking machine for the wattle bark industry
- development of a washing machine for babies' bottles in a maternity ward
- development of a polishing machine for the manufacture of cutlery

#### **Design and manufacturing**

Assistance with the design, development and manufacture of specialized equipment was provided to industry and to other institutions.

#### **Low cost automation**

A symposium on low cost automation was presented in Rhodesia at the request of a group of industrialists.

Six basic courses in low cost automation were presented, namely, three in Pretoria and one each in Durban, Port Elizabeth and Cape Town.

Several candidates who completed the basic course enrolled for one of the two advanced courses that were presented in Pretoria.

Manufacturers were provided with advice on possible applications of low cost automation in their factories and various investigations were undertaken under contract.



# information and research services

## INFORMATION AND RESEARCH SERVICES

Director - D G KINGWILL

The main functions of the CSIR's Information and Research Services (IRS) are —

- the communication of scientific and technical information
- the promotion of scientific research in general
- the promotion of industrial research
- the representation of South African science.

These functions are discharged by various specialized divisions.

### Library services

The success of recently developed specialized information services has resulted in an appreciable increase in the demand for library services. In an attempt to improve these services without undue increase in personnel, a comprehensive investigation into the mechanization of library procedures is being undertaken.

### Source guides

The third edition of the union catalogue *Periodicals in South African Libraries* was published on microfiche directly from computer tapes using COM (computer on microfiche) techniques. This has proved less costly than issuing the catalogue in printed form and it will consequently be possible to produce new editions more frequently.

### Reference, advisory and contract services

Over 500 reference enquiries were dealt with during the year. Several industrial firms asked for advice on the establishment of their own libraries. The services provided ranged from advice on simple accessioning procedures to planning of entire library services and job descriptions for staff to be appointed.

A national information centre on water, acting as an information clearing house for scientific and technical matters relating to water, is now being developed on contract to the Water Research Commission. A documentation centre for matters concerning Lake St Lucia and its environs, is being established on behalf of the St Lucia Scientific Advisory Council on contract to the Natal Parks, Game and Fisheries Board.

After a complete reorganization, the CSIR's foreign language translation service is meeting a consistent demand for the translation of scientific and technical texts from foreign languages.

### Information for industry

About 300 firms now subscribe to the literature current-awareness service for industry. One-day seminars on informa-

tion management and technological forecasting, for the benefit of contact persons in subscribing firms, were held in Pretoria, Cape Town and Durban. In addition, more than 350 liaison visits were paid to industrial firms and more than 800 technical enquiries were handled.

Through the medium of the CSIR's Automation and Production Technology Service, industrialists are made aware of the many types of assistance that the CSIR can provide to industry.

### Computerized information services

The recently created South African Selective Dissemination of Information service (SASDI), which provides a computerized literature reference service to individual scientists and engineers, now has over 200 subscribers of which about half are outside the CSIR. This service is being expanded rapidly by means of personal visits, slide presentations and informal seminars. The service makes use of the following bibliographical data bases: *Chemical Abstracts Condensates* (chemistry and chemical engineering), *Science Citation Index* (multidisciplinary), *Inspecc* (physics, electrical engineering, computer science), *Biological Abstracts Previews* (biological sciences) and *Compendex* (engineering).

Several computerized bibliographical and information services are now being rendered on a routine basis for the benefit of CSIR institutes and outside organizations. Important investigations being carried out include a co-operative MARC (machine-readable catalogue) project on behalf of the National Library Advisory Council, in terms of which the CSIR Library and other participating libraries can make use of machine-readable catalogue information prepared in the USA and the UK; and an experiment with on-line retrospective searching of bibliographical information as well as on-line editing and updating of texts and bibliographical data stored in computer memory.

### Publications

An illustrated popular brochure on the CSIR, which is to be issued in four language versions (English, Afrikaans, German

and French) went to press at the end of the year and should be available early in 1975.

It was gratifying to learn that the CSIR Annual Report and the CSIR two-monthly journal *Scientiae* had won awards at an exhibition of technical publications held in the USA. Both these publications are considered to be important media for informing the world at large of the activities of the CSIR.

To meet the demand for general information dealing with South African scientific activities in the Antarctic an illustrated brochure was produced in collaboration with the Department of Transport (the agency responsible for financing the South African Antarctic expeditions) as a supplement to *Scientiae*.

Preparations for the production of a *Cumulative Index to CSIR Publications* were well advanced towards the end of 1974. Because of prohibitive costs, this index will not be issued in printed form but on microfiche, using the COM (computer on microfiche) technique which has been successfully applied in producing the third edition of *Periodicals in South African Libraries* (see under *Source guides* elsewhere in this report).

#### Publicity services

In addition to liaison with the popular press (press releases, articles for magazines, etc.) contact was maintained with the South African Broadcasting Corporation both in regard to the radio and the proposed television services. Assistance was given to a number of producers making television programmes on such topics as archaeology, lightning research and ecological studies, where CSIR activities were featured.

Towards the end of the year production started on a documentary film dealing with research on the purification and re-use of water. This film, which is intended for showing on the public cinema circuit, is due to be released in 1975.

Activities in the audiovisual field during 1974 were concentrated mainly on the production of automated slide programmes with recorded commentary. Four of these programmes, dealing with the CSIR in general and with specific aspects of its work, were made for special occasions (including the official opening of the National Research Institute for Oceanology) and were well received. These programmes provide an effective and comparatively inexpensive means of conveying information for certain purposes.

Apart from publicizing the work of the CSIR, publicity efforts are concerned with the popularization of science in general. Special assignments include the production of the quarterly review *Scientific Progress* on behalf of the Scientific Advisory Council. During the year, two staff members were awarded the Bleksley Medal by the Science Writers Association of South Africa for a selection of articles published in *Scientific Progress* in 1973.

#### Visitors, functions and exhibitions

In addition to visits by school groups and local visitors, arrangements for visits by a large number of visitors from abroad — including visitors from foreign governments and universities, as well as research and industrial organizations — were made by the central visitors office. A tour around the CSIR campus and the city of Pretoria was also arranged for approximately 450 delegates from overseas who attended the International Sugar Technologists Conference in Durban.

Major functions arranged during the year included the official opening of the National Research Institute for Oceanology in Stellenbosch and a reception in Pretoria for representatives of the Federated Chamber of Industries.

Exhibitions were arranged at the CSIR's regional office in Bellville (in conjunction with the inaugural meeting of the Western Cape Regional Research Liaison Committee), at the

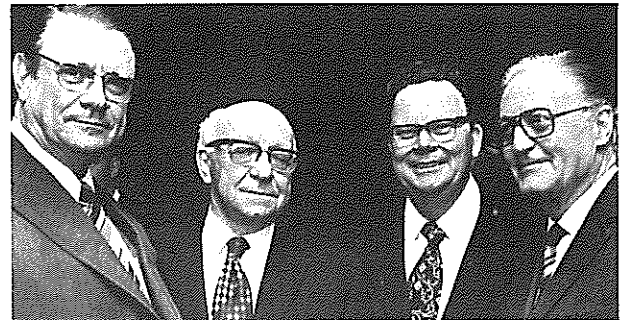
Sugar Milling Research Institute in Durban (in conjunction with an international meeting of sugar technologists) and at the Salisbury Show. These exhibitions, which depicted various aspects of the CSIR's work, evoked considerable interest.

#### Conferences and symposia

Conferences, symposia and seminars arranged during the year covered topics as widely divergent as heat exchangers, weed killers and earth resources technology satellites. Between November 1973 and October 1974 seven large-scale national conferences were organized on behalf of or in collaboration with other organizations, while six one-day symposia and two-day seminars were arranged for CSIR institutes. Future conferences being planned include three large-scale international conferences to be held in 1976.

#### International relations

Apart from its day to day contact with science in other countries, arising from the research activities of its institutes, the CSIR contributes to South Africa's role in international scientific co-operation through membership of twenty-six non-governmental international organizations, one of the most important being the International Council of Scientific Unions



On the occasion of a CSIR Council meeting held in Cape Town Cabinet Ministers, high-ranking officials, leading industrialists, academics and scientists attended a function arranged to present the activities of the CSIR. The photograph shows, from left to right, The Hon. SP Botha, Minister of Water Affairs and of Forestry, Dr The Hon. N Diederichs, Minister of Finance, Dr C vd M Brink, President of the CSIR, and The Hon. J J Loots, Minister of Planning and the Environment

(ICSU), to which several other international scientific unions, commissions, committees and associations are affiliated. During 1974 the CSIR provided the South African delegation to the fifteenth General Assembly of ICSU and also sponsored the attendance of several South African scientists at the business meetings of other organizations of the ICSU family.

#### Overseas offices

As in previous years, the CSIR's overseas offices in Washington, London, Cologne and Paris gave assistance to many South African scientists travelling abroad on tours of duty. Other functions of the offices are to provide assistance with the recruitment of scientific and technical personnel for the CSIR and other South African research institutions, and to facilitate the exchange of scientific and technological information between South Africa and other countries.

Towards the end of 1974 Dr DHR Hellwig took over from Dr WT de Kock as head of the Cologne office, and it was announced that Mr HJ van der Merwe, head of the London office, would



return to South Africa to be replaced by Mr CG Hide early in 1975. The CSIR's office in Paris moved from its old premises into the new Embassy building at 59, Quai d'Orsay.

#### R & D expenditure in South Africa

The surveys of expenditure on research and development in South Africa, undertaken on behalf of the Scientific Advisory Council to the Prime Minister, were continued. These surveys provide valuable information for studies of R & D economics and for the formulation of science policy.

Reports on R & D expenditure by the governmental sector, universities, private enterprises and the Republic as a whole during the financial year 1969-70 were published early in 1974. Similar reports for the financial years 1970-71 and 1971-72 are being prepared.

The basic definitions, conventions and classification schemes used in the surveys were modified in the light of local and international experience. The modified framework will be used for a survey of expenditure during the 1973-74 financial year which has already been initiated.

During the year a sub-committee of the Committee on Research Expenditure of the Scientific Advisory Council was formed to interpret the results of R & D expenditure studies. A number of documents were submitted to this sub-committee for discussions on criteria for interpretation of R & D expenditures and for the determination of a R & D deflator.

#### Techno-economics

In the past the expertise of the Techno-economics Service of the CSIR has been successfully applied to both techno-economic surveys of particular branches of industrial activity and techno-economic contract studies for government, statutory or private bodies.

Although no detailed techno-economic surveys of specific industries were made during 1974, two projects of national importance were started. These were a detailed survey of the accumulation and composition of litter, on behalf of the Department of Planning and the Environment and the 'Keep South Africa Clean' Group, in which very useful information from all over the country was obtained through the friendly co-operation of the Voortrekkers, the Boy Scouts and local authorities, and a techno-economic study of the development and establishment of industries in Coloured areas, undertaken for the Coloured Development Corporation.

In view of the shortages of essential commodities, such as oil, a background study of the probable effects of shortages of petroleum-based and other chemicals is being undertaken.

Several techno-economic contract studies were completed for private enterprises. One of these studies served as the foundation of an extensive advertising and marketing campaign by the sponsors of the study. Because of personnel changes and the entry of private firms into the field of industrial market research, cost studies and economic feasibility studies, the CSIR will in future concentrate on long-term studies.

In accordance with the policy of associating techno-economic activities as closely as possible with laboratory research, a Techno-economics Division was established in the National Food Research Institute. Similar services have been in existence for some years in the National Building Research Institute, the National Institute for Road Research and the Timber Research Unit. The division at the National Food Research Institute was staffed by personnel transferred from the central Industrial Research and Development Group and will devote much of their time to economic aspects of Bantu beer production. It will also

investigate techno-economics aspects of research related to food processing and other beverages.

#### National scientific programmes

A number of co-operative research programmes related to world wide projects initiated by international scientific bodies of which the CSIR is a member, are co-ordinated by the CSIR through its National Scientific Programmes Division. The current programmes are as follows:

**Antarctic research:** Research at Sanae, the South African base on the Antarctic continent and on Marion and Gough Islands, is co-ordinated by the South African Scientific Committee for Antarctic Research (SASCAR). There are three broad fields of research, viz: the biological sciences, the earth sciences and upper atmosphere physics. In addition to the biological programmes already in progress on Marion Island a start was made with seal surveys on Gough Island during the past year. It has also been decided to initiate a programme of marine intertidal biology on Marion Island.

The existing programmes in upper atmosphere physics and earth sciences at Sanae are continuing and it was recently decided to develop a more active programme of cartography.

SASCAR maintains close liaison with the Department of Transport on whose budget provision is made for Antarctic research.



Antarctic research: Research at Sanae, the South African base on the Antarctic continent, and on Marion and Gough Islands, is co-ordinated by the South African Scientific Committee for Antarctic Research. There are three broad fields of research, viz: biological sciences, the earth sciences and upper atmosphere physics. An illustrated brochure dealing with South African scientific activities was produced as a supplement to *Scientiae*, the CSIR journal.

At present attention is being given to the design of a new ship which will eventually replace the relief ship RSA. Special emphasis is placed on the suitability of a ship for oceanographic and other research and provision is made, *inter alia*, for two long-distance helicopters which will operate from the ship and which will greatly facilitate the work related to the earth sciences programme.

**Upper atmosphere physics:** During the past year activities related to the South African Upper Atmosphere Physics Programme centred mainly around preparations for South African participation in the International Magnetosphere Study and the Antarctic and Southern Hemisphere Aeronomy Year, both of which are planned for 1976-78. South African scientists are also involved in the planning of these two programmes on an international basis.

**Meteorology:** South African participation in the World Atmospheric Research Programme has reached the stage where a



An intensive ecological study is being conducted on a bushveld-savanna ecosystem at Nyisvley near Naboomspruit in the Transvaal. The energy budget — from radiant energy, through the photosynthesis of carbohydrates by the green plants, to the animals and the decomposing micro-organisms in the soil — is being mathematically modelled. The very complex tree (*Burkea africana*), shrub (*Ochna pulchra*), and grass (*Eragrostis pallens*) community is shown in the photograph.

number of specific projects have been identified, and arrangements are being made for co-operative participation in the projects.

**Oceanography:** The South African National Committee for Oceanographic Research (SANCOR) on which some 30 organizations in South Africa are represented, paid particular attention to the more detailed definition of the co-operative programmes in the three sub-disciplines, viz: marine geology and geophysics, physical and chemical oceanography, and marine biology.

**Geodynamics:** The National Geodynamics Programme (essentially an intensification of previously initiated research activities in the earth sciences) constitutes the South African contribution

to the International Geodynamics Project, a six-year research programme launched in 1973 by the Inter-Union Commission on Geodynamics of the International Council of Scientific Unions (ICSU). In broad terms the objective of the international programme, in which all major countries of the world are participating, is to obtain a better insight into the dynamics and dynamic history of the earth, with emphasis on deep-seated foundations of certain geological phenomena, such as mountain building, continental drift and the formation of ore deposits.

The National Geodynamics Programme is planned and co-ordinated by the South African Scientific Committee for the International Union of Geological Sciences (SACUGS).

Teams of earth scientists from seven South African universities and the CSIR commenced work on National Geodynamics Programme projects during 1974. The main part of the programme is devoted to intensive multi-disciplinary research on a number of well-defined narrow strips of terrain crossing the orogenic belts of the Cape, the Damara, Namaqualand-Natal and the Limpopo. In addition, comparative geochemical studies are being carried out on oceanic volcanic rocks and those of the Karoo System, with a view to obtaining information on the processes which gave rise to the break-up of Gondwanaland and the subsequent drift apart of the continents of Africa, South America, Australia and Antarctica.

#### Environmental sciences

Research on environmental problems in inland waters, terrestrial biology, marine pollution, solid waste and lower atmosphere problems is co-ordinated in a national programme.

Two large multi-disciplinary programmes involving research scientists from a number of universities, state departments, and institutes are underway. One is an extensive marine pollution survey along the west, south and east coasts (both along the shore and out to sea), in which biological and chemical problems are being studied. The second programme involves a study of the functioning of a bushveld savanna ecosystem in the Transvaal and the energy flow through the system.

A successful National Weeds Conference was organized by one of the Working Groups dealing with terrestrial biological problems.

Lower atmosphere, meso-meteorological problems are also being studied, for example the inversion phenomenon and the lower atmosphere patterns at Richards Bay which will lead to prediction of future pollution patterns after industrialization of the area.



# cooperative industrial research

## FISHING INDUSTRY RESEARCH INSTITUTE

Director - DR R J NACHENIUS

The Fishing Industry Research Institute (FIRI) is affiliated to the University of Cape Town and is located on the University campus.

FIRI is financed by voluntary contributions from the fishing industry and subsidized by the CSIR. Firms with an indirect interest in the fishing industry can become associate members of FIRI. The total annual income of the Institute is currently about R240 000.

The affairs of the Institute are governed by a Board of Control representing the fishing industry, the CSIR, the Minister of Economic Affairs, and the universities of Cape Town and Stellenbosch. Its research programme is planned and executed in consultation with committees comprising the leading technical personnel of the inshore and the white fish industries.

The primary function of the Institute is to conduct fundamental and applied research for the fishing industry. This involves work on various products and processes including chilled and frozen white fish, salting, smoking and drying, frozen whole rock lobster and rock lobster tails, canned pilchards and mackerel, fish meal and fish oil.

The Institute also gives technical advice to the Industry in matters concerning effluent clarification, odour control, the testing of packaging materials, and the purification of processing water. Collaboration with international organizations such as the International Association of Fish Meal Manufacturers and the International Institute of Refrigeration ensures that the industry continues to remain abreast of progress in all fields of fish processing and utilization.

### Effluent treatment

Work on the purification of fish factory effluent makes heavy demands on the Institute's time, as does attendance of senior staff at meetings of committees directly and indirectly connected with the fishing industry.

The fish-meal factories in the Republic have changed to dry off-loading systems or are in process of doing so. This should eliminate the major source of pollution.

In Walvis Bay, the canning branch of the industry continues with wet off-loading; however, the introduction of more sophisticated dry off-loading systems is a likely development.

For the time being the construction of a pilot purification plant has been held in abeyance and technical studies are in progress on aerobic and anaerobic microbiological purification of oxidizable organic matter in the effluents. The efficiency of such techniques in reducing the oxygen demand of the waste water to a minimum not attainable by physical and chemical means is being investigated.

### Better utilization of the catch

Attempts are being made to make better use of fish resources by the preservation and digestion at sea of fish offal and of fish which are not normally used for human consumption and would thus be jettisoned. As mentioned in a previous report good progress has been made with equipment for the manufacture of fish meal on a small scale. Further development is being handled by an engineering firm. Preservation of the fish and offal with formic and/or sulphuric acid is also being investigated. This process has been employed for years in Scandinavia where hydrolysed preserved material is fed to pigs. The alternative method of hydrolysis with the help of enzymes and the drying of the hydrolysate with the object of producing a milk replacer still remains an attractive possibility, but preservation of the material until it has been dried remains a problem. As spray drying must be performed on land the hydrolysate must be preserved on board ship for weeks.

The only fish species which is at present being studied in regard to application for direct human consumption is the sand shark. This shark has a pleasant taste but the meat is inclined to release ammonia, long before there is evidence of decay on account of ageing.

### Quality of white fish

One of the problems faced by the white fish industry in certain foreign markets is the development of a so-called rancid taste in some fish fillets and blocks of minced fish. It has been confirmed that the fat in hake, although present in small quantity only, contains high proportions of the highly unsaturated C20:5, C22:5 and C22:6 fatty acids, and is thus in theory liable to oxidation.

The deterioration in taste is accompanied by a change in texture of the frozen fish. Hake that has been carelessly handled during

freezing and preservation may have a rubbery texture when it is cooked. The use of airtight packing gives reasonable results, but factors other than oxidation cause deterioration. The use of permitted antioxidants has little influence on the keeping qualities of minced fish. Treatment with certain phosphates and amino acids shows promise and is in some cases more effective than airtight packaging. Water binding or the prevention of protein denaturation is obviously of the greatest importance.

Parallel with this work attempts to find objective measurements for quality standards are proceeding so that the standard of the raw material and the efficiency of freezing and storage can be measured.

#### Rock lobster carapace content

Certain overseas buyers of South African rock lobster prefer whole rock lobster (i.e. not tails only) which are exported alive or in frozen condition. In some instances the condition in which the edible contents of the frozen product reaches the consumer falls short of the desired quality.

Attempts to preserve the hepatopancreas and breast meat in good condition continue, but progress has so far been handicapped by the seasonal change in the keeping qualities of the body contents. The change is obvious in terms of the physiological condition of the rock lobster, which is actually never static. Usually, in the frozen state, the digestive organs seem to be satisfactory but on thawing and cooking the proteolytic enzymes of the rock lobster's digestive tract decompose to a certain extent this tract, including the hepatopancreas and the adjoining meat.

Cooking of frozen rock lobster, even by means of microwaves, yields no improvement, while the starving of the lobster before rapid freezing has little or no effect. A series of proteolytic enzyme inhibitors so far tested has also had no effect.

#### Odours and flavours

Work continues to prevent the development of taint in chickens which receive high proportions of fish meal in their rations. It has previously been shown that long chain highly unsaturated acids of the neutral fats (and not the phospholipids) in fish oil, and to a lesser degree certain amines in fish meal detrimentally influence chicken flavour. Subsequently it was established by means of gas chromatography that fish meal, apart from the amines, contains certain sulphur-containing materials and carbonyls which may be associated with the development of taint. The majority of the amines, ketones and aldehydes in fish meal have in fact been identified but their contribution to the problem has not been established.

In present investigations the accent is on the practical aspects of the problem. It has been found that chickens which receive an unusually high proportion of 20 or 10 per cent of fish meal in their rations until they are 7 weeks old, possess a good chicken flavour if they are then fed a ration without fish meal until they are slaughtered 23 days later. Five per cent of fish meal in the ration during the last 5 weeks has little effect on the taste of chicken carcasses and causes no taint, although omission of even this low content of fish meal during their last 23 days produces broiler chickens with still tastier carcasses. Latterly attempts have been made to develop a feeding programme in which the optimum use of the high quality protein of fish meal is combined with the lowest possible effect on carcass flavour.

It has been found that oil in the meal prepared from lantern fish, which is sporadically caught off our West Coast, has a similar effect on the flavour of chicken carcasses to the oil in pilchards, anchovy and mackerel (but not to white fish meal).

#### Evaporation control

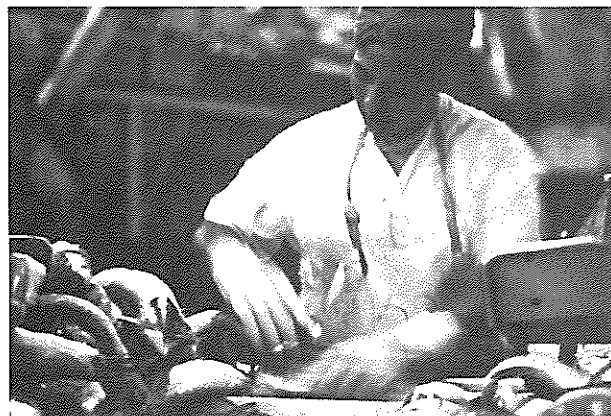
Serious evaporation losses occur in this country where water has to be stored for long periods. For reasons of economy and heat balance, and because dams are used for recreation, the continuous use of evaporation inhibitors for protective covering of water surfaces is not practical. However, such coverings may be of great value in emergency.

Evaporation inhibitors are usually aliphatic unbranched long chain alcohols, which form monomolecular oxygen-permeable films which may reduce evaporation up to 80 per cent. By modification of chain length and other properties attempts are being made to obtain a material which combines effective evaporation inhibition and good mechanical properties (film formation and re-formation after fracture).

The fatty acids of fish oil have promise as a raw material. Small scale preparations are at present on test by the Department of Water Affairs and are furnishing promising results.

#### Protein quality of fish meal

Considerable time has been spent in evaluating two microbiological methods for the determination of the available



White fish being prepared for freezing. Proper handling of fish during freezing and preservation is most important.

(to the farm animal) amino acid content of fish meal. *Streptococcus zymogenes* and *Leuconostoc mesenteroides* were specifically studied with regard to their value in methionine determination, while the protozoan *Tetrahymena pyriformis* W was studied with the object of rating general protein quality. After prolonged testing and checking with, among others, the laboratories where these methods were developed, it has been concluded that they cannot yield reliable absolute values. There is further conclusive evidence that the ability of *Tetrahymena pyriformis* W to digest feeds is limited, and that without preliminary digestion, unreliable results are obtained.

Consequently use is still being made of young chickens in protein evaluation, with the net protein utilization as the criterion. It has again been demonstrated that treatment of raw fish with excess formalin immediately before processing produces a fish meal with a somewhat lower protein quality (for non-ruminants). It has also been shown that the protein quality of meal prepared from lantern fish or East Coast pilchards is not markedly different from the meal made from West Coast pilchards.



Fish meal, like other sources of high quality protein of animal origin, does not have a conspicuous deficiency of any of the amino acids necessary for non-ruminants. Where deficiency in lysine or sulphur containing amino acids was reported, such deficiency could be attributed to the other constituents of the ration. In a series of twelve experiments it has been conclusively shown that lysine is not the first limiting amino acid for young chickens in full fish meal. There were indications that the sulphur containing amino acids in meals stored for more than a year could in some instances be the limiting amino acids, and that glycine might be among the first in very old meals.

Lysine was the first limiting amino acid in fish meal without soluble protein, i.e. a fish meal to which none of the liquid, pressed from the fish together with the oil, is added back.

Protein composition is becoming increasingly important to feed compounders who are turning their attention away from nutritional assessments based on crude protein figures towards a more detailed evaluation of the protein sub-units, namely, the amino acids. Amino acids have in the past been determined by the use of increasingly sophisticated ion exchange techniques. However, the instrumentation is both costly and specialized. It has been shown that suitable derivatives of amino acids can be identified by gas chromatography, and considerable study has



The FIRI devotes considerable study to evaluating the protein quality of fish meal. It has been shown that meals stabilized through the addition of an antioxidant have better protein quality than unstabilized meal of the same age.

been devoted to establishing this facility on a routine basis at the Institute. This has involved investigations into the characterizing chemistry of the individual amino acids notably histidine, threonine, tyrosine and methionine.

The Carpenter method for determination of FDNB available lysine, a property regarded by some in the feed-compounding industry as a criterion of protein quality, is time-consuming when the technique is considered as a quality control test. Various means of shortening and streamlining the method are under investigation. The inclusion of dimethylformamide in the FDNB reaction medium shows promise. This compound acts catalytically to accelerate the reaction some ten times. The hydrolysis step which takes some sixteen hours will also be studied.

## LEATHER INDUSTRIES RESEARCH INSTITUTE

Director - DR S G SHUTTLEWORTH

**The Leather Industries Research Institute (LIRI) is regarded as the pioneer of industrial research for South African secondary industry. From its early beginnings in 1935 in the Chemistry Department of Rhodes University, the Institute has maintained its steady growth over the past forty years and is now spending some R250 000 per annum to serve industries with an output of about 400 times this figure. A feature of LIRI's work has been the balance maintained between fundamental research and the application of science to the everyday problems of the industries served. The high rate of technology transfer achieved has been due to the close personal contact maintained with its many subscribers and the frequency of factory floor contacts between research staff and production managers.**

LIRI is governed by a Board of Directors, consisting of nominees from the CSIR, the Department of Agriculture and Rhodes University with five members elected annually by the subscribers. A Research Advisory Council provides general guidance and is served by seven research committees covering the various groups of subscribers and their manufacturing areas.

### Protein research

The programme of fundamental research into the structure and properties of collagen exposed to various aqueous media is basic to the hide, skin and tanning industries. Apart from this, collagen is a subject of world research activity because it is a major structural protein in skin, bone, dentine, tendon, cartilage and connective tissue. The main structural features of the collagen molecule are well-established and attention is being focused on higher structures, namely the organization of the molecules into fibrils and then into tissue. These aspects are relevant to leather technology.

### Hides and skins

The current awareness of industrial pollution has focused attention on the effluent produced by the traditional method for preserving hides and skins, namely salting, and new techniques of preservation are being studied. These include the use of antiseptics and no salt, and reduced amounts of salt at low pH.

The part-processing of hides and skins to the wet blue stage, to eliminate the need for curing, is also being investigated. This type of raw material raises new problems with fungal growth. This work has opened up a whole new field of study on the microbiology of hide bacteria, with emphasis on halotolerant



and halophobic collagenolytic bacteria and the collagenase enzymes which they produce. These enzymes are responsible for reducing the quality and economic value of hides and skins.

#### Computer services

Special grants from the Livestock and Meat Industries Control Board and the CSIR have enabled the Institute to purchase a Hewlett-Packard mini-computer. This is being used for rapid in-depth analysis of raw experimental data, such as the statistical analysis of factorial-designed experiments, analysis of variance, curve fitting, and the statistical analysis of the physical and chemical test data of various types of leather.

#### Wattle-based adhesives

The fundamental research work on the structure and chemical properties of the tannins contained in the extracts of wattle and related species has enabled LIRI to play a vital role in rescuing this important exporting industry from declining world markets due to synthetic substitutes for outsole leather.

In particular, this work has enabled four successful adhesives to be developed for the timber and cardboard container industries. This has been particularly opportune in view of the shortages and price increases of phenols and resorcinol, and there is world-wide interest in these products. Recent further work points to new methods which might expand the potential even more. Increasingly important tonnages of wattle extract used for timber adhesives are giving fresh confidence to the wattle growers.

#### Self-contained tanning processes

The Liritan no-effluent sole leather process, which has had wide overseas application, and has boosted the sales of wattle extract, has inspired LIRI to study methods of process modification to eliminate the other intractable chemicals in tannery effluent. Methods of recycling chrome tanning liquors have already been taken up by several South African tanneries and are showing worthwhile cost savings in chrome, besides solving an effluent problem.

The use of high percentages of lime in the unhairing process creates serious problems both in liquid and solid waste disposal, and by a combination of reduced lime usage plus partial recycling, methods have been evolved which will ease the problem of effluent treatment and disposal.

A new technique developed by LIRI of dyeing leather by means of foams instead of water solutions, eliminates most of the spent dyestuff. This is being tried on a large scale and seems very promising.

#### Structures of chrome tanning compounds

Using a combination of the latest physico-chemical techniques, LIRI has unravelled the problem of the complex mixture of chromium compounds in chrome tanning solutions. This is a major step forward in the understanding of the mechanism of chrome tanning and should lead to improved tanning technology.

#### Environmental research section

On the initiative of the South African tanning industry, the various industries related to leather have held several meetings



A chromatography apparatus in the LIRI laboratories used for separating protein and chromium complexes.

with representatives of the relevant Government Departments with a view to setting up an Environmental Research Section of LIRI with special finance.

Industries such as hides and skins, fellmongering and tanning, throughout the world are facing increasing stringency in the acceptance of their liquid and solid wastes into the environment, and this is creating a demand for semi-processed or fully processed leather instead of the raw material. This provides an important opportunity for South Africa to expand its exports of raw hides and skins, provided that the effluent problems can be handled.

#### Footwear adhesives

In modern footwear manufacture adhesives rather than nails and threads are used for joining sole to upper. LIRI is carrying out a thorough investigation of modern adhesives and their application, with a view to reducing failures which are expensive both in money and goodwill.



### Troubleshooting

The footwear industry uses an increasing flood of new materials. These, combined with new manufacturing techniques and fashion trends, cause problems and shoe returns. LIRI deals with more than 1 000 problems each year submitted by its subscribers, and solves these both in the laboratory and during frequent factory visits.

### Training

LIRI is responsible for the training of executive and technical staff as well as operatives in the hides and skins, tanning and footwear industries. This follows the Continental system where industrial research and training are operated by the same organization, and has the dual advantage of constantly updating the teaching while providing a recruiting link between university and industry. LIRI courses have been adopted by 23 overseas countries.



A corner of the pilot-scale tannery at LIRI used for research and development.

## SUGAR MILLING RESEARCH INSTITUTE

Director - DR M. MATIC

The Sugar Milling Research Institute (SMRI) is the central scientific organization for research into the manufacturing problems of the South African sugar industry. It was established in 1949 jointly by the South African Sugar Millers' Association Limited (SASMAL), the CSIR and the University of Natal, on whose campus it is

situated in Durban. It is financed by SASMAL and the CSIR.

Eleven sugar factories in Swaziland, Rhodesia, Malawi and Mozambique are affiliated members of the Institute.

The main functions are:

- **Research:** Study of the fundamental aspects of processes such as milling, diffusion, juice clarification, crystallization of sugar and the utilization of by-products, the raising of steam and power and engineering aspects of the design and performance of mills, carriers, evaporators and vacuum pans.
- **Service:** Advisory work, troubleshooting, analysis of sugar — particularly sugar for export — and statistical compilation of manufacturing data for the sugar industry.
- **Training:** A three-year full-time course in sugar technology is offered in conjunction with the Natal College for Advanced Technical Education. The cost of the course is borne by SASMAL and while following the course students are employed by the Institute.

(The sugarcane growers have their own research station at Mount Edgecombe, Natal, where the cultivation of sugar is studied.)

### Cane preparation

With an increasing appreciation of the importance of cane preparation for mill extraction a survey of the existing plant installations was carried out with the intention of determining optimum values for installed power for good preparation. It was assumed that shredded cane having 85 to 90 Preparation Index (PI) could be regarded as well prepared.

When the ten factories reporting PI of 85 to 90 were listed in order of installed power it was found that the range covered was from 85 kW per ton of fibre per hour to 46 kW per ton of fibre per hour. It would appear therefore that to achieve the same result, some plants had nearly double the power installed by others. This led to an investigation of the type of plant installed, to the measurement of the PI after knifing and to a survey of distribution of power between shredder and knives.

It was found, for example, that the overhead anvil plate installations working in conjunction with reversed knives produced excellent PI's. This system appears to be an efficient preparation device. The installation of heavier shredder hammers and massive shredder drives by some factories has undoubtedly given good results.

It would appear, therefore, that provided cane knives and shredder installations are correctly designed, and fed with a continuous stream of cane, 50 kW per ton of fibre per hour can provide PI of 85 to 90. Constant attention to hardfacing of knives and shredder hammer edges, to input power and to anvil settings is required, however, if consistently high PI's are to be achieved.

### Juice clarification

Further juice clarification tests were conducted on an experimental trayless clarifier. This work was mainly aimed at

determining the operating limits of the clarifier and the extent to which the improved clear juice quality was due to the use of flocculants. By operating the conventional Rapidorr at rated capacity and at comparable flocculant levels, a juice of similar quality was obtained but with a fourfold increase in retention time over the trayless clarifier. By varying the pH level of the limed feed to both clarifiers, the importance of adequate pH control for good quality juice from 'fast' clarifiers was demonstrated. The maximum throughput obtained gave a juice retention of only 21.4 minutes, the limiting factor being the size of the feed valve. Indications are that this clarifier could probably operate at higher rates of throughput than those which have been used so far.

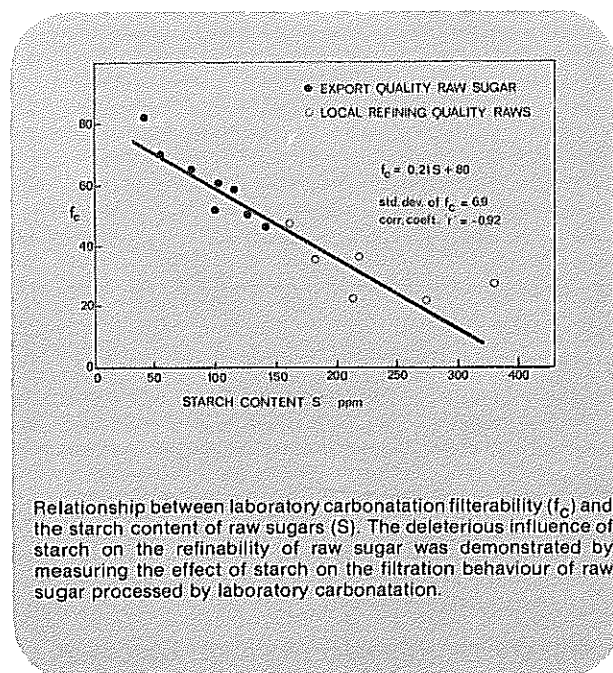
During the course of the 1973 season, a new pilot-plant clarifier was constructed and erected in collaboration with the manufacturers. Designed to be a short retention or fast clarifier, it consists basically of a rectangular tank surmounted by a bank of inclined settling tube modules. A primary separation of the flocculated mud and juice occurs in the tank below these modules, the final separation being achieved by the passage of the juice up the tubes.

Initial test runs have confirmed the ability of this clarifier to operate with a retention time of approximately 30 minutes and work is at present in progress to optimize its performance with respect to juice quality and throughput.

#### Filtering quality of raw sugar

The deleterious influence of starch on the refinability of raw sugar was demonstrated by measuring the effect of starch on the filtration behaviour of raw sugar processed by laboratory carbonatation. The high negative correlation between starch content and carbonatation filterability is indicative of an exceptional relationship between starch and calcium carbonate crystallisation. A detailed analysis of the mechanism of this inter-action has revealed that starch does not perform as a single entity but rather in the form of its two major components, viz. amylopectin and amylose.

Amylopectin is found to be dispersed predominantly within the body of the carbonate lattice. This behaviour is interpreted in terms of the special charge characteristics of the molecule.



Moreover, in this fixed position the influence of the absorbed molecule on the crystal surface properties is limited: the result is that amylopectin is not instrumental in causing excessive filtration difficulties.

Amylose is certainly capable of causing poor filterability. Its activity stems from weakly bonded absorption onto the crystal surface during the course of the reaction. Some of this amylose is incorporated into the growing crystal but mainly it accumulates on the surface, often in such quantities as to alter completely the crystal surface characteristics. The action of amylose as a protective colloid prevents the formation of agglomerates, the presence of which are essential for satisfactory filterability. This is seen very clearly on examining electron photomicrographs of precipitates in which the amylose content varies widely. In case of a high starch raw sugar most particles consist of only two or three crystals which have grown together. In contrast, the precipitate derived from a low starch raw sugar consists of large well-formed agglomerates.

Absorbed amylose also appears to have the propensity to reduce the surface charge of the precipitate, as shown by microelectrophoresis results. This probably causes the interparticle repulsion charge to decrease significantly which in turn would create a drop in filtering rate. It is concluded that amylose has an influence which far outweighs that of amylopectin on the carbonatation filterability of raw sugar.

#### Water pollution

The pilot plant for biological filtration has been operating continuously on a synthetic effluent made by mixing molasses, sugar and water.

Three sets of filters operated as control experiment and were fed with synthetic effluent only. The three other sets of filters operated on an effluent to which nitrogen and phosphorus had been added in the ratio COD:N:P::100:2.0:0.4. This ratio had been found to be the optimum in earlier experiments on an activated sludge process.

Originally the COD of the feed to the filters was kept at approximately 3 000 mg/l. The rapid filters were operating at 9 l/h, while the secondary gravel filters worked at 2 l/h. For both primary and secondary filters the ratio of recycled liquid to forward feed was 3 to 1.

In the control experiment approximately 35 per cent of the COD was removed in the high rate filters, while the total decrease in COD was 65 to 70 per cent. The filters, which were fed with nitrogen and phosphorus enriched effluent decreased the COD in the primary filters by 45 to 50 per cent while the overall reduction in COD was 90 to 95 per cent.

In subsequent experiments the COD of the feed to the filters was increased to 5 000 mg/l, still a comparatively low load, and essentially the same COD removal was obtained. However, additional analyses showed that free and saline ammonia dropped from approximately 10 mg/l nitrogen in the feed to zero in the final effluent. This indicates that the organic load cannot be increased further unless the nitrogen content in the feed solution is increased.



## SOUTH AFRICAN PAINT RESEARCH INSTITUTE

Director - DR D A WILLIAMS-WYNN

The South African Paint Research Institute (SAPRI) was situated on the campus of the University of Natal, Durban, and had close links with the university. Its subscribers included all the main South African paint manufacturers, raw material suppliers and some large-scale paint users. Their subscriptions, if guaranteed for five years, were matched by an equal grant from the CSIR.

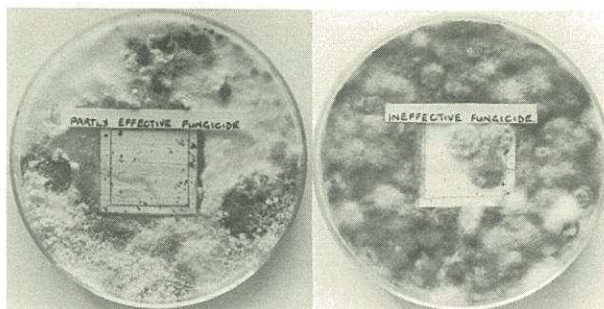
However, the closure of SAPRI with effect from 1975 and the transfer of the assets to the University of Natal means that the Institute will cease to be one of the CSIR sponsored industrial research institutes and the report that follows relates to the final year of operation of the Institute.

Part of the Institute's work was the investigation of paint manufacturing problems and the study of the failure and improvement of protective coatings used in South Africa's rigorous climatic conditions. Since paint is a generic term for a wide variety of formulated products derived from a considerable number of raw materials, both organic and inorganic, paint research involves the investigation of a wide spectrum of chemical and physical phenomena. Long-term studies were initiated by a Research Advisory Panel which included representatives of member firms, the University of Natal, the Corrosion Research Division of the National Chemical Research Laboratory and the Organic Materials Division of the National Building Research Institute.

The Institute undertook research into analytical methods and did specialized analyses, particularly where these involved using apparatus, the cost of which would be uneconomical for individual members. A well-stocked library was available to subscribers, and technical reports and abstracts of published papers in the surface-coating field were issued.

Facilities were provided for outside accelerated weathering studies of paint films, and a sea raft was maintained for assessing the effectiveness of marine paints and anti-fouling compositions. All were available for testing members' products.

Instruments were made, calibrated and repaired in the Institute's workshop, not only for the testing and research staff, but also for subscriber firms for use in their own laboratories.



Agar-plate test for fungicide evaluation

### Film formation and degradation of mature paint films

A study was in progress of the autoxidation of hydrocarbons, and the influence of metal catalysts and various anti-oxidants on the oxidative drying of paint films. This included an investigation of the effect of modification of present curing mechanisms, including radiation curing, in diminishing the degradative reactions in the life of a paint film. This work is to be continued by the University of Natal.

### Assessment of fungicides

The laboratory evaluation of a selection of fungicides and bactericides for use in emulsion paints was pursued, although the use of a tropical test cabinet has given unreliable results. Evaluation of the more promising materials in copolymer emulsion paints applied to asbestos cement panels, had commenced at two exterior exposure sites in Durban.

### Anti-corrosive coatings

Low-toxicity anti-corrosive pigments have been incorporated into primer paints and exposure tests were conducted to compare their effectiveness relative to conventional coatings containing pigments such as zinc chromate or red lead.

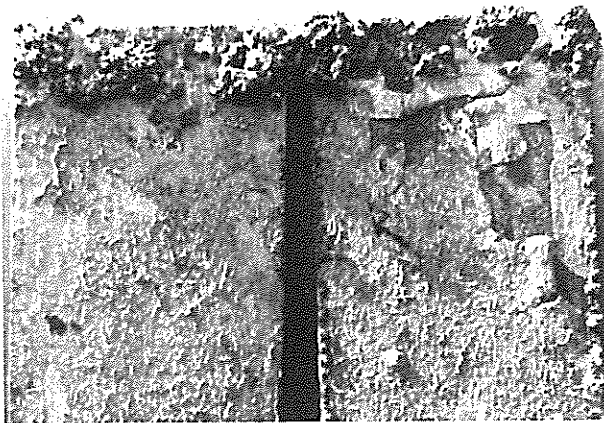
Accelerated testing in the salt spray has not correlated very well with natural exterior exposure of primer coats applied to steel, many of which stood up very well. The Durban atmosphere, which is classed as marine-industrial, is ideally suited to exposure testing of this kind.

### Pollution

The public is becoming increasingly conscious of the harmful effect of poisonous waste materials on the environment and there is a demand for safer products. The studies of the replacement of toxic materials in paints mentioned above is a means to this end, and air pollution also received attention. The paint industry is mainly concerned with solvent emissions, and the photochemical reactions of these and other organic compounds vented to the atmosphere were reviewed.

### Epoxy tar and intercoat adhesion failures

Delamination of multi-coat epoxy tar coatings is sometimes inexplicably frequent, and it was thought that the fault could be



Test for marine paint evaluation.

attributed in part to a water-soluble reaction product (carbamate) formed between the amine curing agent and carbon dioxide in the air. However, results from an experiment designed to test this did not support the theory.

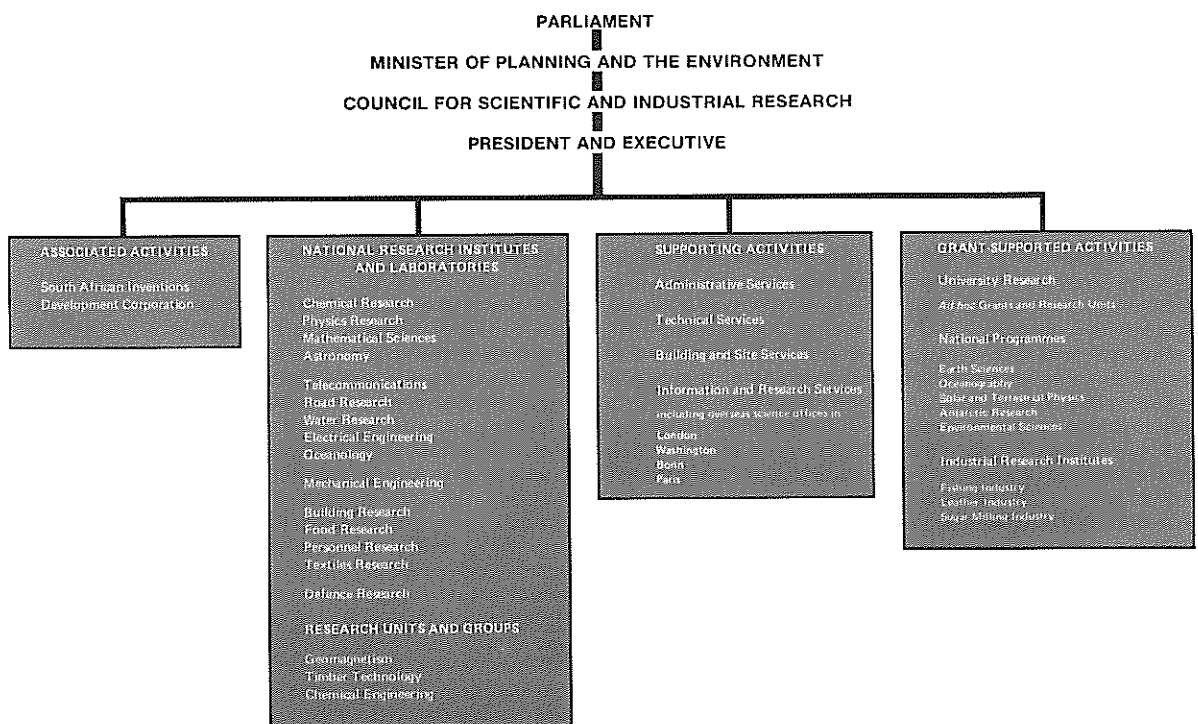
A contributory cause is undoubtedly the quality of the tar used in compounding the coating material since poor performance may be linked with incipient incompatibility which was noted in some cases.

#### Raw materials of local origin

Wattle extract, sugar and cashew nut shell liquid are available locally and a review of the literature and a survey of their potential as paint raw materials was made. Certain derivatives are undoubtedly of interest and may supplement materials in short supply.

#### Analyses and identification of paint products

Scientific instrumentation and test equipment is constantly being updated and the sophisticated apparatus available at SAPRI enabled the Institute to identify and determine most of the raw materials and products of the paint industry. Moreover, the close association with the University of Natal meant that expensive equipment such as nuclear magnetic resonance, mass spectrometry and electron microscopy, and also computer facilities were available.





# financial statements

# BALANCE SHEET

as at 31 March 1974

## State No. 1 Council for Scientific and Industrial Research

	General Fund	Building Fund	1974	1973
	R	R	R	R
<b>ACCUMULATED FUND</b>				
Balance – 31.3.73 . . . . .	27 909 347,53	17 957 919,68	50 157 714,01	45 867 267
Inter-fund transfers . . . . .	(–)390 000,00	390 000,00		
SUB-TOTAL . . . . .	<u>27 519 347,53</u>	<u>18 347 919,68</u>		
<b>CAPITAL RECEIPTS</b>				
<b>Parliamentary Grants:</b>				
CSIR . . . . .	1 315 200,00	1 000 000,00		
Grants . . . . .	65 900,00			
<b>Contributions:</b>				
CSIR . . . . .	14 040,00			
Grants . . . . .	450,00			
Interest . . . . .		178 908,23		
<b>Sale of assets written off:</b>				
CSIR . . . . .	75 627,63	2 620,72		
Grants . . . . .	1 200,00			
Investigations and services	748 761,77	221 747,42		
SUB-TOTAL . . . . .	<u>2 221 179,40</u>	<u>1 403 276,37</u>		
<b>ADD</b>				
Excess income . . . . .	1 307 162,38			
Physical assets acquired . . . . .	(–) 1 281,97			
	<u>3 527 059,81</u>			
<b>LESS</b>				
Physical assets relinquished	35 365,03			
<b>Cost of assets written off:</b>				
CSIR . . . . .	581 209,50			
Grants . . . . .	23 314,79			
SUB-TOTAL . . . . .	<u>2 887 170,43</u>	<u>1 403 276,37</u>		
TOTAL . . . . .	<u>30 406 517,96</u>	<u>19 751 196,05</u>	<u>50 157 714,01*</u>	<u>45 867 267</u>
<b>Current liabilities</b>				
Advances for investigations and services . . . . .			1 719 127,16	999 258
Sundry creditors and credit balances . . . . .			1 699 864,54	1 604 635
TOTAL . . . . .			<u>R3 418 991,70</u>	<u>2 603 893</u>
GRAND TOTAL . . . . .			<u>R53 576 705,71</u>	<u>48 471 160</u>

**Notes:** \* Contractual obligations against the General and Building Fund as at 31st March 1974 were R1 876 856 and R2 310 573 respectively

∅ Value of assets transferred: To: Medical Research Council R35 365,03; Desert Ecological Research Unit R3 805,56 (adjustment of amount on 1970/71 Statement No. 1); From: Port Elizabeth University R2 523,59

(Sgd.) C.v.d.M. Brink, *President*

(Sgd.) J.D. van Zyl, *Actg. Secretary/Treasurer*

PRETORIA 5.8.1974



	1973/1974					
	Nett Additions					
	Grants R	CSIR R	Written off R	Phys. assets transferred d R	1974 R	1973 R
<b>FIXED ASSETS (at cost)</b>						
Land and buildings . . . . .		1 214 498,12			18 487 546,47	17 273 048
<b>SUB-TOTAL . . . . .</b>		<b>1 214 498,12</b>			<b>18 487 546,47</b>	<b>17 273 048</b>
Laboratory and workshop equipment . . . . .	120 986,31	2 527 853,50	483 704,57(-)	[ 33 435,15(-) [ 2 523,59(+)	23 373 301,62	21 239 078
Furniture, fittings and office equipment . . . . .	154,00	173 953,86	12 088,58(-)	548,25(-)	1 566 506,23	1 405 035
Vehicles and cycles . . . . .	225,00	164 256,98	101 980,97(-)	3 805,56(-)	944 458,54	885 763
Books and journals . . . . .	732,13	154 528,86	810,23(-)		1 418 956,55	1 264 506
Prefabricated structures . . . . .		4 942,56	5 940,00(-)	1 381,63(-)	14 603,01	16 982
Shares in S.A. Inventions Development Corporation . . . . .					200 000,00	200 000
Stores stock . . . . .		71 374,91			562 551,75	491 177
<b>SUB-TOTAL . . . . .</b>	<b>122 097,44</b>	<b>3 096 910,67</b>	<b>604 524,35(-)</b>	<b>36 647,00(-)</b>	<b>28 080 377,70</b>	<b>25 502 541</b>
<b>TOTAL . . . . .</b>	<b>122 097,44</b>	<b>4 311 408,79</b>	<b>604 524,35(-)</b>	<b>36 647,00(-)</b>	<b>46 567 924,17</b>	<b>42 775 589</b>
<i>Current assets</i>						
Saleable stock . . . . .					57 506,74	68 410
Sundry debtors and debit balances . . . . .					2 045 555,82	1 444 625
Advances and deposits:						
Research grants . . . . .				510 029,28		
Other . . . . .				735 126,55	1 245 155,83	805 741
Investments . . . . .					2 759 165,13	3 167 947
Cash:						
At S.A. Reserve Bank . . . . .				858 152,51		
At other banks . . . . .				27 000,00		
Petty cash imprests . . . . .				16 245,51	901 398,02	208 848
<b>TOTAL . . . . .</b>					<b>7 008 781,54</b>	<b>5 695 571</b>
<b>GRAND TOTAL . . . . .</b>					<b>53 576 705,71</b>	<b>48 471 160</b>

The above Balance Sheet has been audited in accordance with the provisions of section 56 of the Exchequer and Audit Act, No. 23 of 1956, as read with section 14(1) of the Scientific Research Council Act, No. 32 of 1962, and I certify that it is a true and fair view of the accounts of the Council for Scientific and Industrial Research.

CAPE TOWN  
14.10.1974

(Sgd.) F.G. Barrie  
Controller and Auditor-General

# OPERATING ACCOUNT

for the year ended 31 March 1974

## Statement No. 2

Council for Scientific and Industrial Research

Expenditure	1973/74			1972/73
	Grants R	CSIR R	Total R	
Salaries, wages and allowances . . . . .	96 914,71	19 331 427,22	19 428 341,93	16 224 861
Consumable stores and services . . . . .	5 551,11	7 383 688,16	7 389 239,27	6 094 114
Subsistence and transport . . . . .	13 547,90	1 061 275,44	1 074 823,34	933 570
General expenses . . . . .	2 600,96	2 396 154,75	2 398 755,71	2 231 647
Subsidies: Research by industry . . . . .		381 885,69	381 885,69	356 418
Grants . . . . .	1 168 195,28		1 168 195,28	990 371
<b>SUB-TOTAL . . . . .</b>	<b>1 286 809,96</b>	<b>30 554 431,26</b>	<b>31 841 241,22</b>	<b>26 830 981</b>
<b>LESS:</b>				
Income for internal services . . . . .	733,03	3 522 859,39	3 523 592,42	3 119 852
<b>SUB-TOTAL . . . . .</b>	<b>1 286 076,93</b>	<b>27 031 571,87</b>	<b>28 317 648,80</b>	<b>23 711 129</b>
Balance transferred to accumulated fund	1 850,41	1 305 311,97	1 307 162,38	868 492
<b>TOTAL . . . . .</b>	<b>R1 287 927,34</b>	<b>28 336 883,84</b>	<b>29 624 811,18</b>	<b>24 579 621</b>

PRETORIA  
5.8.1974

(Sgd.) C v.d.M Brink, *President*



Income	1973/74			1972/73
	Grants R	CSIR R	Total R	
Parliamentary grant . . . . .	1 266 100,00	15 021 650,00	16 287 750,00	13 709 200
Investigations and services . . . . .		12 657 302,98	12 657 302,98	9 985 660
Contributions to CSIR projects . . . . .	19 750,00	514 140,66	533 890,66	661 204
Publications . . . . .	2 077,34	28 801,00	30 878,34	21 886
Sundry . . . . .		114 989,20	114 989,20	201 671
<b>TOTAL . . . . .</b>	<b>1 287 927,34</b>	<b>28 336 883,84</b>	<b>29 624 811,18</b>	<b>24 579 621</b>

(Sgd.) J.D. van Zyl, *Actg. Secretary/Treasurer*

# CSIR BUDGET 1974/75

## Statement No. 3

### A. OPERATING EXPENDITURE

ACTIVITIES	EXPENDITURE					FUNDS	
	Salaries	Direct running expenses	Awards and subsidies	Amount internally recovered	Total	Parliamentary grant	Recoverable expenditure
	R	R	R	R	R	R	R
CSIR laboratories and departments . . . .	22 718 935	14 043 885		3 784 729	32 978 091	17 220 400	15 757 691
Grants and subsidies . . . .	208 015	231 727	2 397 402	95 444	2 741 700	2 502 850	238 850
<b>Total . . . . .</b>	<b>22 926 950</b>	<b>14 275 612</b>	<b>2 397 402</b>	<b>3 880 173</b>	<b>35 719 791</b>	<b>19 723 250</b>	<b>15 996 541</b>

### B. CAPITAL EXPENDITURE

ACTIVITIES	EXPENDITURE						FUNDS		
	Books/Journals	Technical equipment	Furniture/Office equipment	Vehicles	Stores stock	Buildings	Total	Parliamentary grant	Recoverable expenditure
	R	R	R	R	R	R	R	R	R
CSIR laboratories and departments . . . .	124 115	2 351 565	126 800	320	50 000	1 190 000	3 842 800	2 848 200	994 600
Grants to universities etc. . . . .		15 900	900				16 800	16 800	
<b>Total . . . . .</b>	<b>124 115</b>	<b>2 367 465</b>	<b>127 700</b>	<b>320</b>	<b>50 000</b>	<b>1 190 000</b>	<b>3 859 600</b>	<b>2 865 000</b>	<b>994 600</b>
<b>GRAND TOTALS A &amp; B</b>							<b>39 579 391</b>	<b>22 588 250</b>	<b>16 991 141</b>



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