fluctuations in river flow can be accounted for by precipitation. To obtain better results there must be close collaboration between meteorology and hydrology. Further information is required on snowfall and its rate of melting. The factors affecting evaporation are very complex, and although considerable work has been done on this problem, it seems unlikely that reliable estimates can be made at present. River flow records are therefore an essential factor, not only for determining the actual run-off but also as a means of finding out about storage and evaporation.

The technical problems involved in gauging the flow of a river were described by Capt. W. N. McClean. When measurements are required, it is seldom practical to construct a special weir or flume, and in these circumstances the best method is to select a stable reach and measure the flow through this with a current meter. Readings must be taken over the whole cross-section area and integrated to give the total flow. Means of locating the current meter quickly and accurately are of great practical importance, and some details were given of a suitable cableway which could be stretched across the river and from which the meter could be lowered at any selected point to the required depth. Measurements of flow have been made for several rivers in Scotland, and fifteen years of continuous records for five of these have been published in tabular form by Capt. McClean. But much more work is required. Water is a very valuable asset, more valuable even than coal, and yet there is no Inland Water Survey in Great Britain. Recent flood damage on the main railway line north of Berwick might well have been averted had there been adequate rainfall and run-off data available to the engineers who designed the line. The silting up of estuaries and the design of hydro-electric schemes are also problems for which river flow records are essential. There is a great need for an organised survey, calling for close co-operation between the Ministry of Health, the Ordnance Survey, the Meteorological Office, the Ministry of Agriculture and Fisheries, and the various river boards and water supply authorities.

Mr. W. Allard, of the Ministry of Health, explained how it is that in the past so little attention has been given in Great Britain to river flow recording. Water supplies are abundant, and there has been no difficulty in meeting the small requirements. In the case of the Thames, very complete data exist; records of the flow at Teddington weir go back as far as 1883. In due course, no doubt, the various river boards will put forward their own suggestions for surveys. Both graphical and tabular methods of recording river flow were considered by Mr. Allard, and it was shown how such data could be used to predict floods and to estimate the changes in flow which would result from a given precipitation.

A lively discussion followed in which all agreed that a more complete survey of river flow is most desirable. Mr. E. Gold pointed out that the average flow gave little useful information and that it was important to know the fluctuations. The Zambesi Falls were given as an example. Here the average annual ratio of maximum to minimum run-off is about 30 to 1, which makes the falls almost useless as a source of hydro-electric power. There were, however, considerable differences of opinion as to the best method of making the measurements. Mr. R. V. Stock, of the Thames Conservancy, described the system of weirs in use at Teddington and explained how it was intended to extend and improve them, to obtain greater accuracy especially at times of minimum flow. Sir Claud Inglis stated that weirs and throated flumes gave the best accuracy, but Capt. McClean maintained that the propeller type of current meter could give excellent results, and, further, could be used on any stable reach of a river without the need for special constructional work. Mr. J. F. Francis, however, doubted if the latter could provide measurements accurate to better than a few per cent; for very low rates of flow, propeller gauges are not reliable.

COMMONWEALTH COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

THE twenty-first annual report of the Council for Scientific and Industrial Research*, Commonwealth of Australia, covering the year ended June 30, 1947, states that consideration was being given to the establishment of two divisions for textile research, one for fundamental work on the chemistry and physics of the wool fibre, and the other to concentrate on the technology of the spinning and utilization of wool. It was hoped at an early stage to commence some work on the degreasing of wool with hydrocarbon solvents as distinct from the normal soap and water scours, and that university research workers will be encouraged to study the fundamental structure and properties of the wool fibre. Other new developments include the appointment of an officer to take charge of the Meteorological Physics Section, where work for a few years will centre on the detailed examination of the atmospheric conditions over a small area. Arrangements have also been made by the Council for a small co-operative section of metallurgy to be accommodated at the University of Melbourne. The initial programme of work will include studies of the properties of metals at high temperatures, the preparation of metal compacts from metal powders and the application of X-rays to studies of metals and alloys. A small team of engineers and chemists has been collected to study the utilization of atomic energy for industrial purposes; this team will work at Harwell, England, and arrangements have also been made for a co-operative programme of research in nuclear physics at the University of Melbourne. A Tracer Element Research Committee has been appointed to advise the Council in work with radioactive isotopes.

Reports have indicated that much of the trouble existing in Australian coal mines could be alleviated by applying established methods of dust prevention, and it has also been recommended that a more detailed survey should be made of the conditions in the mines and into the best means of measuring dust concentrations; and as a result of the visit of the late Prof. T. David Jones, the Council has established a Coal Dust Research Advisory Committee to advise on a programme of research. Attention was also given to the scientific aspects of plans for the Australian Expedition to the Antarctic during 1947–48. The Expedition was expected to pay particular attention to geophysical problems, including meteorology, the earth's mag-

* Commonwealth of Australia. Twenty-first Annual Report of the Council for Scientific and Industrial Research for the year ended 30th June, 1947. Pp. 139. (Canberra: Commonwealth Government Printer, 1948.) 6s.

netism, cosmic rays and, possibly, radio propagation. The scheme for overseas training is now in full operation, and twenty-five officers were abroad during 1946–47. Special emphasis is also laid in the report on the increasing help given to the Council by the universities.

The work of the Division of Plant Industry has continued on similar lines to those described in the previous report. Work on weeds has now been divided into two sub-sections—physiology and ecology. The former is concerned with the physiology and biochemistry of plants as related to the penetration and translocation of plant poisons and with the development of more efficient herbicides. The ecology sub-section is concerned with the determination of the ecological factors pertaining to the invasion and establishment of weeds, particularly in grassland, including the testing of herbicides in the field. The search for native plants as sources of supply for medicinal drugs and insecticides has continued, and a list of publications of the Division during the year is appended.

In the Division of Economic Entomology, the most important development during the year has been the change in the cattle-tick situation as a result of the thorough establishment during the year of the practicability and efficacy of using a water-miscible preparation of D.D.T. in dipping-vats. This preparation was developed in June 1946 by a team of the Division's workers in Queensland.

Much of the work of the Division on the chemical control of insect pests has been concerned with the use of D.D.T. and 'Gammexane', very promising results being obtained in Western Australia with these dusts against the red-legged earth mite. Biological-control investigations form a major part of the Division's activities and have progressed very satisfactorily. The introduced insect enemies of St. John's wort continue to clear land of the weed at an undiminished rate, and new projects which have been initiated include: the introduction and breeding of parasites of the cabbage moth; a biological study of the Dawson River sandfly; laboratory studies of factors controlling the levels of insect populations; and ecological studies of cockchafer beetles. A meeting of the Codling Moth Committee, at which all the State Departments of Agriculture were represented, as well as the Waite Agricultural Research Institute and the Division itself, was convened at Canberra in May 1947. The Division of Animal Health and Production continued its work on the usual lines, but difficulties arose in all branches of the work, mainly through the shortage of accommodation supplies and staff. Plans for the development of the work on animal breeding, genetics and animal production, however, were advanced during the year, and in the Department of Biochemistry and General Nutrition increased attention has been given to research on more fundamental spheres of the nutritional physiology of sheep.

Soils investigations have again largely been concerned with areas intended for land-settlement schemes for returned servicemen and especially those areas in which a major change in the use of the land is contemplated, such as from dry farming to irrigation or from native vegetation to seeded pastures. Studies on soils associated with toxæmic jaundice of sheep have continued, while, besides the investigation of methods of determining phosphates in soil, a new method has been developed for the determination of molybdenum in plant materials. The principles underlying retention of water in soils have been further studied, and investigations, which were commenced for the Building Materials Section, on soil as a foundation material for houses, have continued.

Considerable progress is reported in forest products investigations, and fundamental studies on wood chemistry and pulp and paper problems have been continued in co-operation with the pulp and paper industry. With the object of accumulating the requisite background and information for an examination of saw-mill design, saw-mill studies have been carried out in Queensland in co-operation with the Queensland Sub-Department of Forestry and the Queensland Timber Stabilization Board, and in Victoria with the Victorian Saw-millers' Association. Work on the thermal conductivity of wood and on creep in initially green beams has continued, and an attempt was made to standardize the methods of electrical strain-gauge manufacture and to improve the technique of the manufacturing process. Other work, on the seasoning and the preservation of timber, particularly the preservative treatment of the tree-wood of eucalypts of lower durability for railway sleepers, has yielded important results; and work on the latter problem has indicated that a study of the diffusion of electrolytes into timber offers a possible approach to fundamental aspects of the physical chemistry of wood.

Besides the changes in food-preservation investigations recorded in last year's report, the Physics and Transport Section has commenced a major investigation of the transport of frozen produce in insulated railway vans, and more attention has been given to several long-term chemical and biological studies. Investigations of the volatile organic substances from Granny Smith apples, the mechanism of catalytic oxidation of ascorbic acid by metals, and the stability of dehydroascorbic acid were carried out; the anti-bacterial properties of cationic detergents, the maturation or tenderizing of beef, the damage to beef casings by *Dermestes vulpinus*, and skin coatings for apples also received attention; and the programmes of work on fruit canning and the dehydration of fruit and vegetables have been carried out. Further progress is reported in the development of the schedule of fisheries research, but, although all sections of the freshwater, estuaries and inshore programme were extended, deep-sea investigations on pelagic fish occurrences with the motor vessel *Warren* could not be resumed until January 1947. During 1947–48 it was hoped to extend the exploratory and survey work to tropical waters. An exceptionally interesting report records progress in survey work or investigations on pilchards, sprats, anchovies, whitebait, trawl fish, Australian salmon, mullet, shellfish, marine crayfish, etc., as well as in hydrological and seaweed investigations.

The Division of Metrology reports increased attention to the maintenance of standards and associated research, including the measurement both of mass and length and associated quantities. The Division of Electrotechnology has likewise been able to give more attention to fundamental research and is developing its research activities mainly on the electrical and magnetic properties of materials and mathematical instruments; work in the former direction has been so far confined to dielectrics, including the treatment of glass, steatite and other siliceous compounds to improve their electrical insulation resistance to moist atmospheric conditions, and the relation between molecular structure and

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dielectric properties of insulating materials. A more balanced programme of work has been possible in the Division of Physics, where about half the time of the scientific staff is now available for research. Three new major projects have been commenced: the setting up of equipment for research at very low temperatures; laboratory investigations on the artificial production of rain; and the absolute measurement of ultra-violet spectral energy distributions with the view of determining solar energy distributions. Advice has been given on special devices for temperature measurement and control, and work is also reported on the physical phenomena involved in the formation of ice crystals, on the physics of solids, photometric standards and evaporation plant.

In the Division of Aeronautics greater concentration on the fundamental and long-term projects was also possible, and, while the Australian Council for Aeronautics was disbanded during the year and will be replaced by a research committee, the relations of the Division with the Universities of Sydney and of Melbourne have already been strengthened. Reference is made in the report to work on such varying topics as the stability of plates and shells, the life of aircraft and effect of temperature on their strength, fatigue of metals, properties of alloys, powder metallurgy, high-speed subsonic and transsonic flow, the use of suction to increase efficiency at moderate speeds, piston-ring lubrication and the elimination of wear due to dust. In the Division of Industrial Chemistry progress is reported in the inauguration of ceramic research, but the work of the Biochemistry and Organic Sections has been handicapped by absence of proper accommodation. Construction of a new building was expected, and in the meantime the work of the Division has continued much on the lines described in the last report. Collaboration with the Division of Physics in studies of the structure of the wool fibre continued, and theoretical and experimental investigations have been conducted on luminescent materials used in the lamp and radio-valve industries.

Work in the Division of Radiophysics has led to fuller knowledge of the radiations emitted at radio frequencies from the sun and in the universe. This Division has opened up a promising new avenue of research which should provide basic information on the physics of cloud formation and may lead to the practical possibility of stimulating rainfall by artificial means and to the completion and successful demonstration of new radar aids to civil aviation. The Section of Tribophysics has confined its work on lubrication mainly to a study of the frictional properties of molecular layers of lubricating substances. Wear is being studied by mechanical and metallurgical methods as well as with a radioactive tracer technique. The group dealing with the mechanical properties of metals is endeavouring to obtain a better knowledge of the properties of metallic crystals and the way the mechanical properties in particular are changed by heat. The work on explosives has already made substantial contributions to knowledge of the mechanism of explosion in liquids.

The work of both the Building Materials Research Laboratory and of the Flax Research Laboratory has been seriously handicapped by limited accommodation and, for the former, by the further difficulty in recruiting staff. Nevertheless, weathering studies have proceeded, as well as investigations on concrete, masonry, surfacing materials, building boards and insulating materials, adhesives, etc. The Dairy Research Section, which has now incorporated the Dairy Section of the Division of Industrial Chemistry, has studied the advantage of eliminating the washing of buttermilk from the butter granules, weed taint in butter and the utilization of the solids of skim milk. Among miscellaneous investigations is included an account of the study of the growth and rubber content of the guayule plant under Australian conditions at the Waite Institute, Adelaide, which was commenced five years ago and which is now approaching a stage when interesting and important comparisons will be possible.

DESIGN OF RADIO AERIALS

THE number and diversity of the radio communication services now in operation in an overcrowded spectrum demands that the utmost efficiency must be obtained in the design and operation of both sending and receiving stations. At the transmitting end it is necessary that the minimum power be used and the radiation be concentrated in the desired direction; while at the receiving end aerials of high directivity are also required in order to ensure that the incoming field produces a satisfactory signal, to the exclusion of any unwanted noise or radiation coming from some other direction.

Thus, in point-to-point communication it is desirable to make the two aerial systems as directional as possible. At fixed frequencies high directivity can be obtained by using aerial-array, long-wire, or rhombic aerial systems, but if several frequencies are to be used with the same system, aerial arrays are unsuitable.

A report which will help the engineer in designing a radio communication service for maximum efficiency has recently been published*. It presents in a convenient form a generalized analytical method of calculating the polar diagram of any long-wire aerial system over a wide band of frequencies. The analysis is also applied to the determination of the polar diagrams of horizontal rhombic aerials.

The object of the paper is to describe the simple theory of long-wire aerials in such a manner that the physical principles involved may be readily understood and the results applied to special or new systems. Methods are developed whereby the probable polar diagrams of long-wire systems may be rapidly estimated for a wide range of operating frequencies or for changes in other parameters. These may be used to reduce the work involved in calculating an accurate polar diagram in which allowance is made for second-order effects; the technique is to sketch the approximate polar diagram given by the simplest theory applicable to the problem, and then to calculate the exact values for the important maxima and minima. The results of the analysis are presented in the form of design charts with such information as: families of contour curves of constant directivity against angle of azimuth and elevation for a constant frequency; or as curves giving the position and relative amplitude of the main lobes in the vertical plane through the aerial against angle of elevation and frequency. A similar treatment is

* Department of Scientific and Industrial Research. Radio Research Special Report No. 16. A Method of Determining the Polar Diagrams of Long-Wire and Horizontal Rhombic Aerials. By W. R. Piggott. Pp. iv+39. (London: H.M. Stationery Office, 1948.) 9*d*. net.