RECENT SCIENTIFIC INQUIRIES IN PARLIAMENT

THE Parliamentary Secretary for Science, Mr. D. Freeth, dealt with a further 25 questions relating to science in the House of Commons on July 18, answers to which occupy 20 columns of the Official Report. Replying to a question about non-ferrous mineral resources in Cornwall, Mr. Freeth said that the results of a comprehensive study have been published in a Geological Survey memoir on the Metalliferous Mining Region of South-West England in 1956. Airborne geophysical surveys were undertaken in 1957, 1958 and 1959, and at present airborne magnetic surveys were being extended to the off-shore areas.

On international co-operation, Mr. Freeth said that high cost is an important but not the only factor in deciding whether an international project is desirable. The United Kingdom is participating in the European Organization for Nuclear Research, in the *Dragon* and *Halden* reactor experiments of the European Nuclear Energy Agency, in the Anglo-United States *Scout* satellite programme and a project for European space flights is under consideration.

Membership of the Machine Tool Industry Research Association incorporated in November 1960, includes 64 machine tool manufacturers representing about half the output of the industry, and 20 manufacturing firms in allied industries.

Repeated investigations by the Medical Research Council have shown no evidence of a higher incidence of lung cancer or respiratory disease among persons exposed to increased amounts of Diesel exhaust fumes. No figures are at present available to indicate the effect of Diesel smoke on road safety, but the Department of Scientific and Industrial Research is collaborating with the Minister of Transport in efforts to ensure the correct maintenance and operation of vehicles which will eliminate satisfactorily the nuisance from this source. Mr. Freeth also said that the Warren Spring Laboratory of the Department of Scientific and Industrial Research has examined methods for removing smoke from the exhausts of Diesel-propelled road-vehicles, but no device yet tested has proved satisfactory. The British Internal Combustion Engine Research Association is undertaking fundamental work on the combustion process in Diesel cylinders which it is hoped may lead to remedial measures. Mr. Freeth said it is a fact that correct setting of the injectors and their proper maintenance and operation provide a simple and effective remedy.

In answer to a series of questions on cancer, Mr. Freeth said that work on geographical variation in cancer incidence is already being supported by the Medical Research Council and no promising lead on cancer or similar diseases will be held up through lack of Government funds. The Medical Research Council's expenditure from public funds on cancer research was £327,000 in 1955–56 ; £400,000 in 1956–57 ; £486,000 in 1957–58 ; £499,000 in 1958–59 ; £583,000 in 1959–60 ; £650,000 in 1960–61 ; and would be about £783,000 in 1961–62. No reliable estimate can be made of expenditure on research relevant to cancer in the universities and medical schools in Britain from funds provided by the University Grants Committee, or in the National Health Service during the treatment of patients.

Other answers were as follows: The annual output of qualified scientists would be about 6,900 in the present academic year, compared with less than 5,000 in 1956, and the annual output of qualified technologists has grown from 6,200 to more than 9,600 in the same period. The Research Councils, for which the Minister for Science is responsible, are providing about £250,000 in the current year for expenditure on printing, publications and other forms of publicity. The Department of Scientific and Industrial Research at present operates 13 research grants with six different universities or colleges, and 6 further grants are contemplated. It is also intended to extend the use of scientific methods by the Geological Survey. A Committee of the Royal Society, at the request of the Advisory Council on Scientific Policy, is considering existing arrangements for supporting fundamental research in biology.

ATOMIC ENERGY RESEARCH AND DEVELOPMENT IN BRITAIN

THE seventh annual report of the Atomic Energy Authority covers the period April 1, 1960–March 31, 1961*, in which the Authority had in hand a special survey of its future requirements, both of man-power and finance, to ensure that its demands on Britain's resources do not exceed the minimum required for the efficient discharge of its responsibilities. This survey is additional to the periodic reviews made to ensure that the choice of reactor systems for major development and the priorities between them are firmly based. Although the review is still proceeding, its existence offers some re-assurance that developments on the part of the Central Electricity Generating Board will not lead to inappropriate duplication of effort. An increase in staff from 38,500 to 40,840 during the year is reported, industrial employees rising from 19,572 to 20,606.

On the civil side, the development of nuclear reactors to generate electricity on an economic basis remains the Authority's principal objective, and work for the nuclear power stations under construction, particularly the development and manufacture of magnox fuel elements, occupied a substantial part of the Authority's scientific and technical resources. Work on possible reactor systems for nuclear ship propulsion, production of radioisotopes (sales of which rose by 10 per cent to total nearly £21 million during the year) and development work on their applications, basic nuclear science, work on health and safety

* United Kingdom Atomic Energy Authority. Seventh Annual Report for the period 1st April, 1960–31st March, 1961. Pp. viii + 80 + 4 plates. (London: H.M.S.O., 1961.) 5*s*. net.

problems, and fulfilment of international obligations account for most of the Authority's remaining scientific work. Production of fissile material was up to programme, and unit cost was reduced by improvements in efficiency. The Calder and Chapelcross reactors, designed primarily to produce plutonium, are supplying more than 2,000 million units of electricity to the grid annually, and the stage has now been reached when the reactors are capable of generating more steam than can be used by the installed turbine capacity; turbo-alternators are being modified accordingly. In an experiment in a Calder reactor some of the standard fuel elements reached an exposure far in excess of their designed endurance. The production of a much more advanced type of fuel for the prototype advanced gas-cooled reactor at Windscale began during the year, and the main chemical extraction plant at Windscale successfully processed all the irradiated fuel from the eight Calder and Chapelcross reactors. A new separation plant is being constructed to process the irradiated fuel which will arise from the nuclear power stations operated by the electricity boards. The efficiency of the diffusion plant at Capenhurst was improved by about 4 per cent, and in addition to the highly enriched material taken from the top end of the plant, uranium hexafluoride was drawn off from the cascade at low enrichment to meet requirements for the prototype advanced gas-cooled reactor and for other research and development projects. In view of the great progress made since 1951, when work on the centrifuge method of isotope separation was abandoned, in fields such as vacuum engineering, the handling of uranium hexafluoride, and the design of gas bearings, a small development programme has been initiated to examine possible effects on this method of separating isotopes and the bearing of the new technologies on technical aspects of disarmament.

Research and development undertaken in connexion with specific reactor systems are described in a separate chapter dealing with the reactor development programme. Research and development carried out with wider objectives, for example, the broad attack on scientific nuclear power problems, such as the effects of radiation on materials, the nuclear properties of materials and their effect on reactor performance, the chemical behaviour of materials in a reactor and heat-transfer problems, fundamental research in branches of science of particular importance to the Authority, and the research on isotopes or large sources of radiation, now centred on Wantage, are described in a further chapter. During the year, 517 technical reports have been published as well as 335 research articles by the Authority's staff in scientific periodicals, and lists of these publications are available on request. A further chapter of the report is devoted to controlled thermonuclear research.

Obviously it is only possible to select a few points for emphasis, and indeed even the Authority's report does not claim that its review of research and development is other than selective. A comparative economic study of various marine reactor designs made during the year indicated that, because of the comparatively small size of such reactors and the stringent safety precautions necessary if present reactor designs were installed in a ship, none of the designs at present in an advanced state of development is feasible, and the Authority is now considering the use of more advanced systems which are in a much earlier state of development. Much attention was paid to the reaction between graphite and irradiated carbon dioxide under the operating conditions of the Windscale advanced gas-cooled reactor, and the design for a large civil advanced gas-cooled reactor was carried forward in more detail. The Dounreay fast reactor is already fulfilling its purpose of developing the technology of fast reactors generally, and the next stage is intended to be a plant from which commercial fast reactors will be designed; work on this during the year was concerned mainly with reactor physics, engineering design study and the development of the fuel element, while work was started on the fabrication and irradiating-testing of possible fast reactor fuel elements. Much of the effort in support of the high-temperature gas-cooled reactor concept has been directed towards the 20 MW. (H) *Dragon* reactor experiment being built at Winfrith under the auspices of the Organization for European Economic Co-operation, but possible applications of this system to marine propulsion units and to large, land-based power stations are also being investigated. The way in which both gaseous and non-gaseous fission products diffuse out of graphite crystals and also through the pores of a polycrystalline mass of graphite is being studied. In preliminary work on the steam-generating heavy-water reactor system, a series of reactor physics experiments was performed in the *Dimple* and *Lido* research reactors.

In general research, investigations of the effect of irradiation on graphite, using the high-flux research reactors *Dido* and *Pluto*, suggested that changes produced by irradiation are essentially due to groups of interstitial atoms which congregate if the graphite is heated during or after radiation. The effect of neutron irradiation on the physical and mechanical properties of beryllium is being studied using electron microscope 'thin-film' techniques. In the increasing research on ceramic fuels a novel technique has been developed for the preparation of uranium carbide, with low open-pore space, by the 'reaction sintering' of uranium and carbon powders. Experiments on magnesium oxide have shown that its brittleness is due to the presence of surface cracks, less than one thousandth of an inch in length, which grow during deformation and lead to fracture. Investigations at Harwell directed towards studying the gas- and solid-flow patterns in fluidized material have shown that the roof of a bubble is robust, that a pocket of gas does not rise through a rain of solid particles, and that streams of gas adjacent to bubbles enter through the sides and bottom of the bubbles and rise inside them, suggesting that bubbles may help to promote gas mixing. A new method of automatic monitoring for beryllium has been developed in which a stream of the air to be examined is passed between platinum metal electrodes. A spark discharge between the electrodes excites the emission of light with wavelengths characteristic of any materials suspended in the air, and the light characteristic of beryllium can then be isolated and detected photoelectrically within a minute. A promising technique is being investigated in which wet steam is used as the cooling agent; if water is present as a film or spray, very high efficiencies for removal of heat can be obtained. In controlled thermonuclear research, work continued on the containment properties of the toroidal pinched discharge in *Zeta*, the ring-shaped apparatus in which deuterium gas is heated to high temperatures by an electric discharge. Investigation of plasma containment by magnetic fields oscillating at radio-frequencies have also been made, and in theoretical work attempts are being made to develop basic theoretical

plasma physics, especially stability theory, to give predictions a secure foundation and to analyse individual experiments in detail, using available theory, to supplement and interpret the diagnostic measurements, suggest new experiments, and check the theory itself.

In written answers in the House of Commons on July 19, the Parliamentary Secretary for Science, Mr. D. Freeth, said that the volume of design work on reactor systems and other plant associated with the civil nuclear power programme carried out by industry on behalf of the Atomic Energy Authority is at the same level for 1961–62 as for 1960–61. The Authority received £2 million from the sale of fuel-elements in 1960–61, in addition to £6·5 million advance payments received in 1959–60, and expected to receive about £13 million from such sales in 1961–62. The three completed fuel canning lines at Springfields are fully employed, and all five lines are expected to be in production by May 1962, when the factory should be capable of meeting all demands now foreseen for natural uranium fuel-elements canned in magnox. It will be necessary in due course to plan new facilities for the fabrication of uranium oxide fuel elements if it is decided to include power stations using such elements in the nuclear power programme.

The Atomic Energy Authority now employs 350 professional staff on design studies and research and development for the prototype fast reactor, compared with 200 a year ago; but when full design and construction of a prototype commercial reactor can begin will depend on progress in developing a suitable fuel. Of the Authority's professional staff engaged on civil research and development, the proportions working on the main reactor systems in 1961 were: magnox reactors, 15; advanced gas-cooled reactors, 20; fast reactors, 14; high-temperature gas-cooled reactors, 8. In 1960 the corresponding figures were 20, 20, 9 and 8, respectively.

The Authority has in hand an intensive programme on the development of plutonium fuel elements for the prototype fast reactor. The fuels include mixed plutonium and uranium dioxides in a steel matrix and mixed plutonium and uranium carbides. The programme involves the preparation, irradiation testing and examination of specimen fuel materials, investigation of methods of making complete fuel elements and their testing under irradiation, and investigation of the behaviour of the fuel elements under conditions simulating those expected to be experienced in a power reactor. The number of professional staff engaged on the development of fast reactor fuels has approximately doubled since last year. It is not at present planned to run the Dounreay fast reactor completely on plutonium fuel, but shortage of plutonium is not holding up the development of fuel elements in the fast reactor. Ten engineers from the industrial consortia are attached to experimental reactor projects compared with 26 a year ago, and the Authority maintained a close association with the industrial consortia through a Nuclear Power Collaboration Committee and its supporting technical committees, including a joint committee which advises on the design and development of the Authority's experimental reactor projects and on advanced reactor systems. All information derived by the Authority on reactors is available to the industrial consortia through the Authority's reports, and the technology and progress have been discussed jointly under arrangements made by the Nuclear Power Collaboration Committee.

THE BRITISH GELATINE AND GLUE RESEARCH ASSOCIATION

THE twenty-first meeting of the Research Panel of the British Gelatine and Glue Research Association was held on May 17, under the chairmanship of Mr. S. G. Hudson (Richard Hodgson and Sons, Ltd.). The chair was taken in the afternoon by Mr. C. F. C. Simeons (British Gelatine Works, Ltd.).

Mr. W. G. Cobbett (British Gelatine and Glue Research Association) gave the first paper entitled, "Rupture Properties of Gelatine Gels". An apparatus has been built for the extension of dumb-bell shaped strips. The gels are cast from 10 per cent gelatine solutions in 'Perspex' moulds and are matured at 10° C. Extension is then performed at chosen constant rates, the gel strips being floated on mercury at 10° C. Rupture properties are more closely related to jelly strength (rigidity) than to the 40° C. viscosity of the gelatine solution. Thus gelatines with similar viscosities break at loads which follow the order of their jelly strengths while gelatines with similar jelly strengths are not greatly influenced in their breaking loads by differences in viscosity. The extension at rupture is greater for gelatines of higher jelly strength when the viscosities are equal, but is also higher for gelatines of higher viscosity where the jelly strengths are similar. The slope of the linear (lower) portion of the load-extension graph is directly related to the jelly strength as measured on the Bloom gelometer.

Discussion on the paper was opened by Prof. A. G. Ward, who had initiated the project in 1957. He recalled that the work was begun to provide information on the mechanical properties of gels in relation to food uses. The field was largely unexplored and it would be desirable to examine a series of fractions and a selection of total samples exhibiting extreme values in other physical properties. The lively discussion which followed showed that there was considerable interest in exploring the effects of additional variables on the extension properties of gelatine gels, for example, gel concentration and *p*H, chemical modification, including cross-linking, and dilution with additives such as water-soluble block polymers.

Dr. A. Courts presented his recent work on "Structural Re-orientation of Gelatine in Citrate". He has investigated the rise of viscosity with time which aqueous solutions of gelatines undergo over a period of days at moderate temperatures ($< 25°$ C.). The effect is enhanced several-fold in the presence of certain buffers, and most work has been done with approximately 0·3 per cent solutions in 0·15 *M* citrate at 20° C.; the rise is rapid during the first day, is slower but linear over the next 3–4 days and thereafter falls off. The rise is maximal near *p*H 7 and is unrelated in magnitude to the viscosity (log. viscosity number) of the sample and hence to its weight average molecular weight. It is dependent on the rigidity modulus of the gelatine and a quantitative relationship exists between the linear portion of the rate of viscosity increase and the rigidity. The increase in viscosity