DUTCH – NORWEGIAN JOINT ESTABLISHMENT FOR NUCLEAR ENERGY RESEARCH

REPORT FOR 1954–55

THE fourth annual report of the Dutch–Norwegian Joint Establishment for Nuclear Energy Research (J.E.N.E.R.) covers the period from July 1, 1954, to June 30, 1955*, and reports that at Kjeller the natural-uranium heavy-water research reactor, JEEP, has completed its fourth year of operation, yielding 50 MW.-days of heat during the year. A great variety of research work has been done, both in connexion with the design of reactors and of a more fundamental nature, but the principal task of the Establishment is research in the field of nuclear power.

The original design for a pressurized heavy-water reactor, using natural uranium as fuel and heavy water as moderator and coolant, as a power demonstration reactor has been shelved, and instead work has been concentrated on a boiling heavy-water reactor running on slightly enriched uranium and delivering 10 MW. of heat. The Norwegian organization, Institut for Atomenergi (I.F.A.), which together with the Dutch organization, Stichting voor Fundamenteel Onderzoek der Materie (F.O.M.), operates the Joint Establishment, has proposed to the Norwegian Government to build this reactor at Halden, in Norway, 100 km. south of Oslo. The site is on the premises of a paper-pulp plant, Saugbrugsforeiningen, which is interested in the future possibilities of supplying process steam by nuclear reactors, the area being far away from reserves of hydro-electric power. The firm will buy the steam generated in the experiment and will support the project in general. The reactor, except for the control room, will be entirely underground in an artificial cave in the mountainside.

Sales of radioisotopes produced in JEEP increased by 85 per cent more than the previous year. 579 shipments were made, and an additional 262 irradiations were carried out for use within the Establishment. Some radioisotopes, such as labelled compounds and isotopes requiring a high neutron flux which are not easily produced at Kjeller, were imported mainly from the United Kingdom Atomic Energy Authority. The Isotope Department continued its radioisotope service for industry, and a number of new technical applications have been carried out, some of which are briefly described in the annual report.

The neutron diffractometer described in the report for 1953–54 has been improved by the addition of a neutron monitor so that it now gives the number of neutrons scattered by a crystal in a certain direction for a given number of neutrons incident from the reactor, instead of for a given length of time. The angular resolution has also been improved, and a second 'two circle' instrument especially designed for studies of single crystals has been recently put into use. Most of the research work on crystal structures, using neutrons, has been concerned with the determination of 'light' atoms in the presence of 'heavy' atoms, and the substances investigated include CuH, Al_2Th and $Ca(H_2PO_2)_2$. The fission process, the basic process underlying the operation of reactors, has been the subject of experimental and theoretical studies during the year under review, and the angular correlation of fission products, the high-energy gamma radiation from fission fragments and the hazards which might arise from the continuing heat generation from fission products in the event of an accident to a pressurized boiling-water reactor system are some of the topics discussed in the report. A large liquid-scintillation fast-neutron detector, consisting of an aluminium tank, 30 cm. diameter and 30 cm. high, containing an organic scintillator into which cadmium or boron is introduced and viewed by four photomultipliers with 5-in. diameter photocathodes, and a time-of-flight spectrometer have been constructed for studies of fast neutrons.

Work in the Chemistry and Metallurgy Departments has continued on the study of plutonium chemistry and the reprocessing of spent fuel rods, the nuclear properties of uranium oxide fuel rods and full-scale corrosion tests on fuel elements under dynamic conditions. The Health Physics Department has kept constant control of radiation hazards; of the 111 individuals exposed to radiation, not one received a radiation dose greater than half the permissible working dose recommended by the International Commission on Radiological Protection. Five reports and two publications of the Establishment were issued during the year. 300 books, 25 periodicals and 8,500 reports were added to the library, including a technical library consisting of about 6,500 reports (4,900 on microcards), twenty-eight bound volumes of the U.S. Atomic Energy Commission's "National Nuclear Energy Series", a complete set of *Nuclear Science Abstracts* and other material presented by the Commission.

The final sections of the report deal with the accounts of the Establishment for the period under review; the personnel in the various departments; and the various scientific meetings and conferences attended by members of the staff of the Establishment.

* Fourth Annual Report, July 1954–June 1955, of the Dutch–Norwegian Joint Establishment for Nuclear Energy Research. Pp. iii + 34. (Kjeller, near Lillestrøm: J.E.N.E.R., 1956.)

MECHANISM OF INSECT FLIGHT

FLIGHT by means of flapping wings demands a higher rate of energy consumption than any other known activity in the animal kingdom. But in no single bird, or bat, or insect has the aerodynamics of the process been closely analysed. Indeed, some authors have claimed that the observed movements of insects would not permit flight in accordance with ordinary aerodynamic principles. This subject is now being studied with all the care it deserves by T. Weis-Fogh and M. Jensen, and their first four papers have been published under the general title of "Biology and Physics of Locust Flight" (*Phil. Trans. Roy. Soc.*, B, 239, 415; 1956). Dr. Weis-Fogh is an entomologist and physiologist (a student of the late August Krogh, who took an active part in the early stages of the work); Dr. Jensen is an engineer with a special knowledge of the aerodynamics of aircraft. Two of the papers are under joint authorship, and the other two by each author alone.

From a critical review of the available information the authors conclude that natural flight is almost certainly based on conventional aerodynamic principles, even in such small insects as mosquitoes. The energy account of a wing stroke comprises at least three independent terms: an aerodynamic term due

to the wind forces on the wings, an inertial term due to acceleration of the wing mass, and an elastic term caused by the elastic deformations of the thorax. In addition, there may be some extra-muscular damping within the thorax.

In order to analyse how the various wing-stroke parameters are related to the *lift* and the forward *thrust*, the locust was suspended from a complicated balance and flew against a uniform wind the speed of which was automatically adjusted to the point where the thrust was equal to the drag of the body, thus indicating the flying speed. This speed averaged 3·5 m./sec., but might be as much as 4·5–5·0 m./sec. during the first minutes of flight. The power necessary to overcome the drag of the body was only 1–3 per cent of the total metabolic rate; and changes in the inclination of the body up to 20° had no effect at all on the lift, in striking contrast to the effect of pitch on an aircraft. Most of the parameters of the wing stroke are remarkably constant, such as the stroke angles, the stroke plane angles, the middle position of the wings and the time course of the angular movement. Even the stroke frequency showed a maximum increase of 8 per cent during the most active lift. It is therefore concluded that, by analogy with a variable-pitch propeller, the great variations in lift must be caused by differences in *wing twisting*. It is rather remarkable that over the whole range of temperature (25–35° C.) at which flight occurs, the standard wing stroke is completely independent of temperature.

In a detailed analysis of the aerodynamics of locust flight it was found that the calculated vertical lift force, when averaged over an entire wing stroke, equalled the average reduction in body-weight as measured directly on the flight balance. Likewise, the average thrust of the wings as calculated, corresponded with the measured drag of the body. The hind-wings are responsible for about 70 per cent of the total lift and thrust, about 80 per cent of the lift being produced during the down-stroke.

As already noted, the wing stroke of locusts is extremely constant and independent of external conditions. The question arises whether the rhythm is imposed by the central nervous system or peripherally. In the fourth paper of the series, Weis-Fogh discusses some of the sensory mechanisms concerned in locust flight. As is well known, flight can be initiated by the 'tarsal reflex'—sudden removal of contact with the legs; but this causes only about five seconds of flight, or about a hundred wing strokes. Sustained flight is dependent upon the blowing of air over the wind-sensitive hairs on the head. The direction of the air current is immaterial, and, since static bending has no effect, the adequate stimulus is probably minute vibrations of the hairs. A new receptor system is also involved in the maintenance of flight. The adequate stimulus is the rhythmically changing wind-pressure on the wings. The receptors perhaps reside in the wing-hinge, but they have not yet been identified. Finally, in addition to the wing-stroke movements being strikingly constant, there is a very accurate control of the lift; this presupposes a system of lift-sensitive receptors (probably campaniform sensilla at the wing-hinge) which control reflexly the wing-twisting angle.

This important work is still incomplete; six further sections are in preparation.

ENZYMIC AND CHEMICAL SYNTHESIS OF THE ALPHA-1 : 2-GLUCOSIDIC LINKAGE

Enzymic Synthesis

WHEN the dextran-producing organism *Betacoccus arabinosaceous* is grown on a medium containing sucrose and an appropriate second sugar (to serve as an acceptor of transferred glucose units) oligosaccharides are produced in appreciable quantities[1]. A particularly interesting example is the formation of the 'branched' trisaccharide, O-β-D-galactopyranosyl-(1→4)-O-[α-D-glucopyranosyl-(1→2)]-D-glucopyranose, from a mixture of sucrose and lactose[1]. It is now shown that, as was envisaged earlier[1], cellobiose behaves in an analogous fashion to lactose and gives rise to the 'branched' trisaccharide, O-β-D-glucopyranosyl-(1→4)-O-[α-D-glucopyranosyl-(1→2)]-D-glucopyranose. The preliminary chromatographic evidence upon which this work is based was obtained by our former colleague, Dr. R. W. Bailey.

The new trisaccharide was isolated by the charcoal column method[2] from a culture of *Betacoccus arabinosaceous* (Birmingham strain), which had been grown on a medium containing yeast extract, inorganic salts, sucrose (10 per cent) and cellobiose (30 per cent).

The molecular size was confirmed by oxidation with hypoiodite[3] and by ionophoresis of the benzylamine derivative in formic acid[4]. Acidic hydrolysis gave glucose as the only product detectable by filter-paper chromatography and by ionophoresis in borate (*p*H 10)[5]; partial hydrolysis yielded components corresponding to glucose, cellobiose and a second disaccharide (*Y*). The reducing power of the trisaccharide towards the Shaffer–Hartmann copper reagent[6] was only about 2·5 per cent of that of glucose, a discrepancy which is shown generally by 2-O-substituted glucoses[1]. Moreover, the trisaccharide and disaccharide *Y*, in common with the analogous trisaccharide derived from lactose, were not developed by alkaline triphenyltetrazolium chloride, which detects all reducing glucosaccharides except those with a 2-O-substituent[7]. Further evidence that the reducing unit of the trisaccharide was linked through position 2 was obtained when treatment with phenylhydrazine acetate yielded a mixture of two osazones, similar to cellobiosazone and glucosazone on microscopic examination.

That one of the glycosidic linkages in the trisaccharide was α and the other β was shown (*a*) by its $[\alpha]_D$ value (+93° equil.; conc. 1·00 in water) and also that of the alcohol derived from it (+89° equil.; conc. 1·00 in water), (*b*) by its infra-red absorption spectrum, which displayed a peak at 840 cm.$^{-1}$ (α-linkage) in addition to those given by cellobiose[8], and (*c*) by its conversion to glucose and disaccharide *Y* with almond β-glycosidase.

This enzymic hydrolysis proceeded much more slowly than with β-linked disaccharides. The