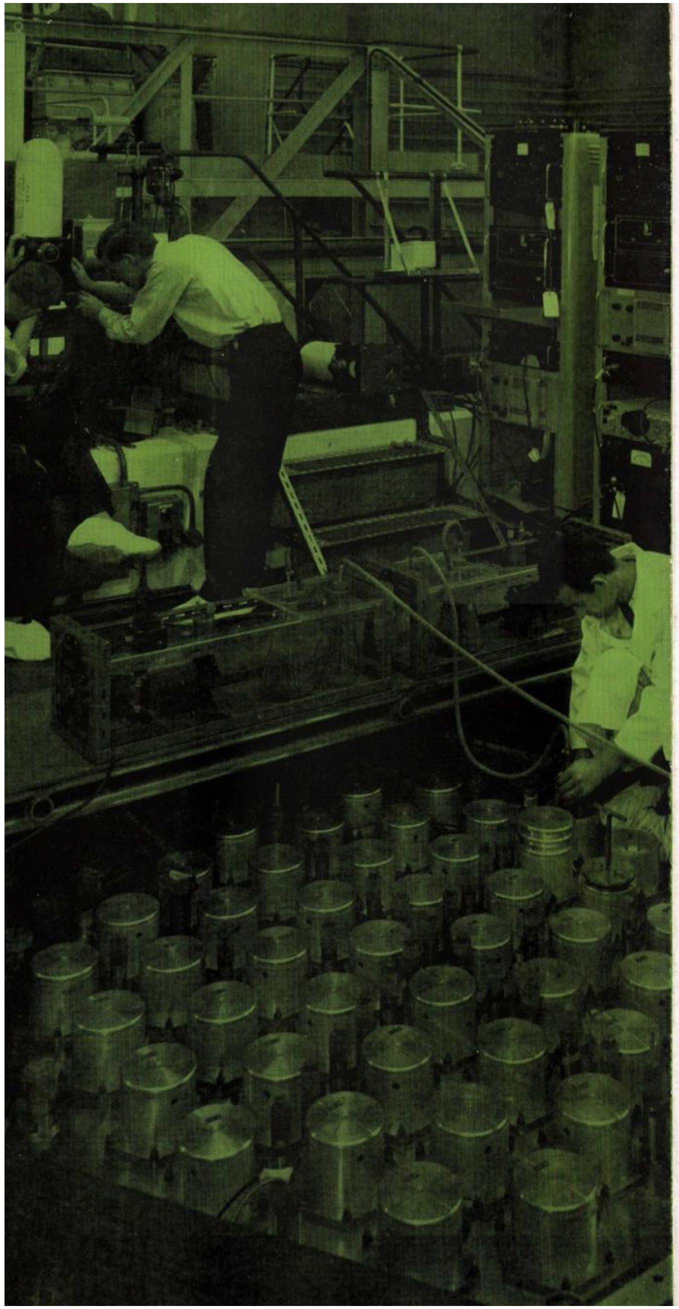

The U.K.A.E.A.

From its beginning in 1945 until 1954, the British atomic energy project was conducted by a Government Department. In July, 1954, however, the U.K.A.E.A. was set up, the reasons for its formation being announced as follows:
'As the industrial uses of atomic energy become relatively more prominent, the case for a form of control of the project which is more akin to the structure of a big industrial organisation than to that of a Government Department becomes increasingly strong . . .'

The Authority is managed by a Board of which the Chairman is Sir Roger Makins, the Deputy Chairman, Sir William Penney, and on which there are a number of full-time and part-time Members. The Authority is divided into five main Groups.

RESEARCH GROUP

The Research Group (Director, Dr. F. A. Vick) has its headquarters and largest laboratories at the Atomic Energy Research Establishment at Harwell, where basic research is carried out into nuclear science and the materials of atomic energy. Plasma physics and fusion research are carried out at Culham, Oxfordshire, and the production and distribution of radioisotopes is based at the Radiochemical Centre at Amersham.

WEAPONS GROUP

The Weapons Group headed by Air Chief Marshal Sir Claude Pelly has its headquarters at the Atomic Weapons Research Establishment, Aldermaston, and undertakes design and development of atomic weapons. This Group also undertakes fundamental research, for instance in metallurgy, fuel element design and on controlled thermonuclear reactions.

REACTOR GROUP

The Reactor Group, with headquarters at Risley, Lancashire, is headed by Sir William Cook. This Group designs, constructs and develops nuclear power reactors and includes the Dounreay Experimental Reactor Establishment, Scotland, and the Atomic Energy Establishment at Winfrith, Dorset. It also acts as engineering consultant for the electricity boards, overseas organisations and the British consortia formed for the building of nuclear power stations.

PRODUCTION GROUP

The Production Group is headed by Sir Leonard Owen, and has its headquarters at Risley. This Group operates the nuclear reactors at Calder Hall and Chapelcross. It manages the uranium and plutonium production factories at Springfields in Lancashire, Windscale in Cumberland and Capenhurst in Cheshire and consults with industry on the sale of nuclear fuel, exploitation of patents and other commercial activities.

ENGINEERING GROUP

The Engineering Group is also headed by Sir Leonard Owen at Risley. This Group is responsible for the design and construction of Authority plants, works, buildings, and for the design and inspection of fuel elements for production purposes.

Front cover: The Advanced Gas-cooled Reactor at Windscale.

Left: A heavy water moderated assembly at Winfrith, used for studying reactor design problems.

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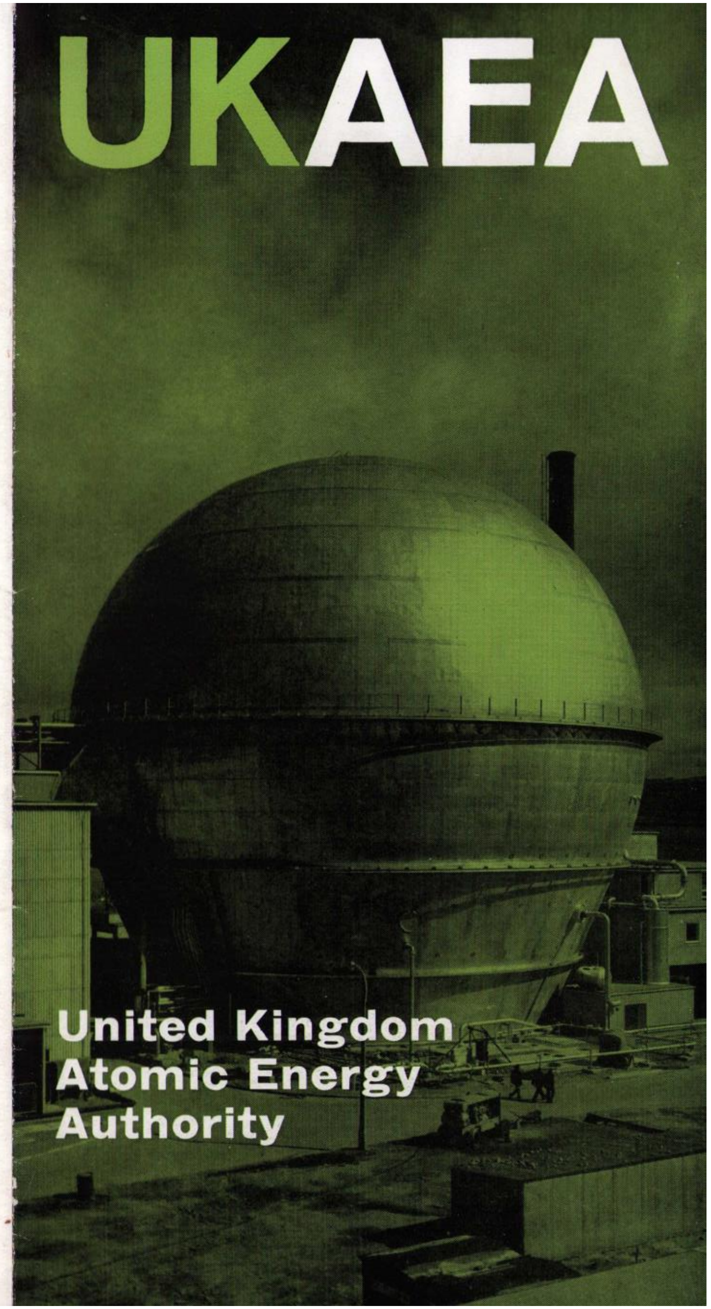


The nuclear power programme

The Production Group of the U.K.A.E.A. has, as one of its main functions, the production of fuel for nuclear reactors and fissile material for the defence programme. Uranium ore concentrates are imported into Britain and processed to make these reactor fuel elements.

Large scale manufacture of uranium fuel elements for nuclear power reactors is undertaken at the Springfields Works (near Preston) and plutonium is extracted from irradiated fuel elements at the Windscale Works (in Cumberland).

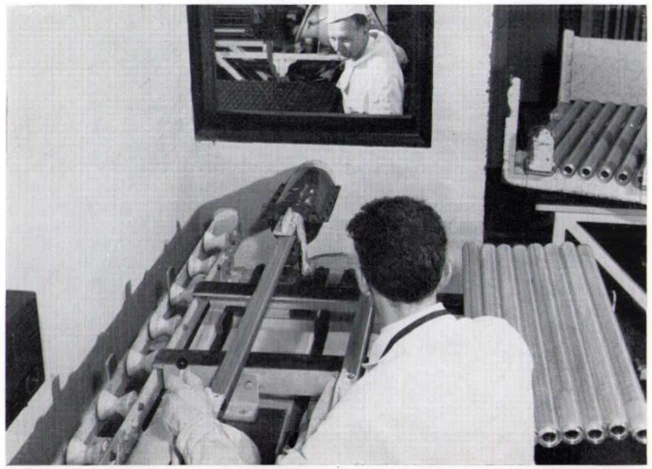
The Group is also responsible for the operation of the Calder Hall and Chapelcross atomic power stations. The former, opened in October, 1956, was the world's first nuclear power station to generate electricity on an industrial scale. Chapelcross is similar to Calder Hall and began supplying electricity to the national grid in February, 1959. Over 9,000 million units of electricity have been generated by these two stations.

The Reactor Group of the U.K.A.E.A. develops, designs and constructs new types of reactors. A prototype of an advanced gas-cooled reactor (A.G.R.), a development from the Calder Hall type, has been constructed at Windscale. It operates at a higher temperature, with consequent greater efficiency, and uses uranium oxide pellets as fuel, contained in stainless steel cans. It is expected that power stations with reactors of the A.G.R. type could be built by the end of the decade and that for a similar output the capital cost of an A.G.R. station would be substantially less than that of the nuclear power stations now being built.

The fast breeder reactor experiment at Dounreay went critical in November, 1959. This reactor is designed to use very rich fuel and to produce more fissile material than it consumes. Fast breeder reactors might be available for power production in the early 1970's, using the plutonium produced in the earlier stations based on Calder Hall.

The high temperature reactor is a gas cooled, graphite moderated reactor which will operate at temperatures even higher than those of the A.G.R. The major part of the A.E.A.'s work on this system has been in support of the DRAGON Project — a reactor experiment at Winfrith, under the auspices of the Organisation for Economic Co-operation and Development.

Loading uranium fuel cans at Springfields works, Lancashire.



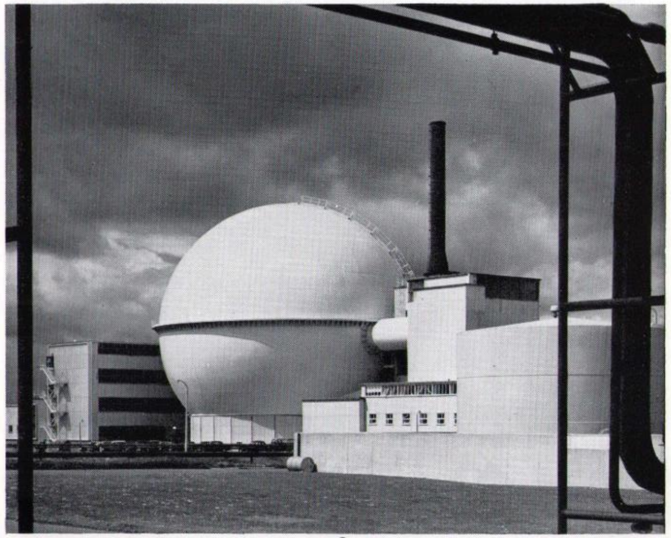
A programme of research and development intended to elucidate key problems of the steam generating heavy water reactor type to assess its suitability for power production is being carried out in collaboration with Atomic Energy of Canada Limited. Sub-critical assemblies of this reactor type are in use at Winfrith.

Britain announced the world's first nuclear power programme in February, 1955. This has now been revised and the Government has decided that new orders for nuclear stations should be placed at the rate of roughly one a year, which should provide about 5,000 MW of nuclear capacity by 1968.

The first two stations, Berkeley and Bradwell, started producing electricity in 1962. A further six are under construction at Hunterston, Hinkley Point, Trawsfynydd, Dungeness, Sizewell and Oldbury. The next station will be at Wlyfa Head in Anglesey and have a capacity of 1,000 Megawatts. The U.K.A.E.A. acts as a technical adviser to the electricity authorities for the reactor portions of these stations.

The U.K. has been able to assist other countries to take early advantage of nuclear power. British designed nuclear power stations of the Calder Hall type are being constructed by British firms in Italy in co-operation with Italian manufacturers, and in Japan, in collaboration with the Japan Atomic Power Company. Overseas firms can also acquire the benefit of years of British experience of the gas-cooled graphite-moderated reactor by direct agreement with the British consortia. For instance, a German firm has an agreement with one of the British consortia for access to 'know how' and experience on improved Calder type reactors. The U.K.A.E.A. assists such negotiations, and supports British firms by making fuel available to their customers.

The experimental Fast Breeder Reactor, Dounreay



Using a radioactive technique to detect a leak in a water main.

Radioisotopes

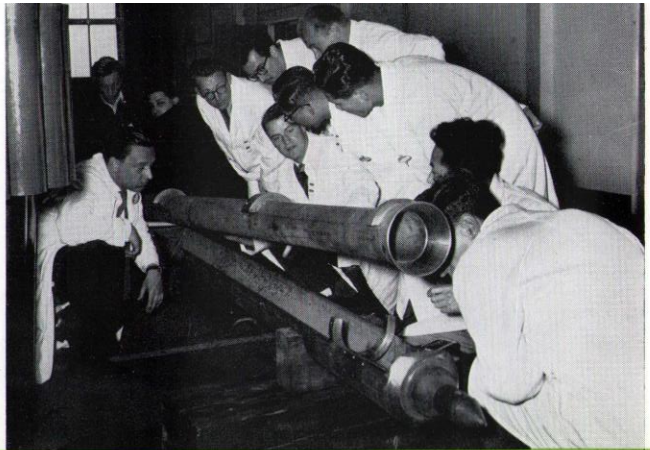
Radioisotopes have for years been proving of great value in medical research, diagnosis and treatment, as well as in agriculture, research and industry. Since 1947, when the first atomic pile came into operation at Harwell, Britain has established a large and growing export trade and now sends isotopes to some 70 countries overseas.

The Radiochemical Centre at Amersham, Bucks, receives most of its raw materials from the Authority's reactors and prepares a comprehensive range of radioactive materials, including primary radioisotopes, natural radioelements and labelled compounds. The wide range of products is conveniently divided into two catalogues, 'Radioactive Chemicals' and 'Radioactive Sources', which are available on request. In addition to the standard range of products, the Radiochemical Centre undertakes special preparations to meet particular requirements.

Amersham scientists have satisfied most of the demands made for radioactive synthesised compounds put to them. They have also achieved considerable success in making use of elements from the fission products of atomic piles such as radioactive caesium and strontium.

An essential feature in the use of radioisotopes is speed of delivery — since some isotopes decrease in radiating power very rapidly over a few days. Therefore air transport is normal procedure for overseas delivery. In Europe deliveries are generally made within 48 hours, and even in Australia or Japan the user can receive his material in less than seven days after cabling his order.

To assist industry to effect the savings made possible by the use of radioisotopes, an Isotope Information Bureau has been opened at the Authority's London Office.



Students at the Calder Operations School study the working of charge-channels, through which fuel elements are loaded into reactors.

Going to school

British experience in the field of nuclear energy is passed on to students at three U.K.A.E.A. Schools where scientists from all over the world receive training at Authority establishments.

The Isotope School, which moved recently from Harwell to Wantage, has been in existence since 1951 and gives to graduates instruction in the properties of radioactive materials, measuring instruments and laboratory techniques used with radioactive isotopes. By the end of 1962, over 3,000 students from 72 countries had passed through the School. Of these over 1,500 had attended special courses, which included a short course designed for directors, on the applications of radioactive isotopes, courses on isotopes in medicine, courses on radiological protection, non-destructive testing, and so on.

The Harwell Reactor School (opened in September, 1954) holds regular courses of basic training in reactor technology and radiation protection and shorter, specialised courses in reactor instrumentation. In addition, special courses are run for science masters and for university engineering staff and more general courses for senior technical executives. More than 3,500 students had passed through the School by the end of 1962.

The Calder Operation School was opened at Calderbridge, Cumberland, in January, 1957. Designed to train students from British industry and from overseas countries in the operation of Calder Hall type reactors, the School's training courses provide an outline of the design and construction of the plant, commissioning tests and information of operating experience. Training at the School includes work on a large analogue computor which simulates the control problems of an entire nuclear power station. Over 750 students had attended the various courses by autumn 1962.

The work of the School is now being extended to include a four-week course on "Nuclear Power Reactor Systems". This course is designed for the technical executive who wishes to study the reactor systems in operation, or at the large scale development stage, in the United Kingdom. Eight engineers from overseas attended the first of these courses.

Atomic energy research

The principal task of the Research Group is basic research and early development work on the peaceful aspects of atomic energy. The Atomic Energy Research Establishment at Harwell, which is the headquarters and the largest establishment of the Research Group, was started in 1946 and is now world-famous.

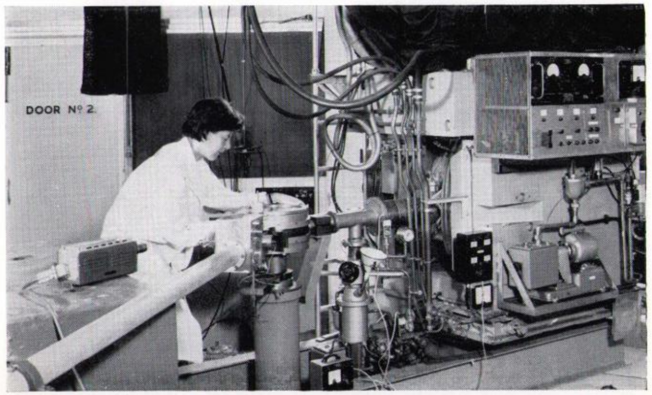
Harwell's work includes basic research in physics and chemistry, obtaining better nuclear data, research into the chemistry and metallurgy of reactor materials and into supporting nuclear technologies, health and safety research, and the development of radioisotope applications. Among the major installations at Harwell are six research and materials-testing reactors, a number of accelerators for producing powerful beams of neutrons and other nuclear particles (including a synchrocyclotron, a 12 MeV tandem accelerator, and a linear accelerator with a neutron-multiplying target) and extensive radiochemical, metallurgical and chemical engineering laboratories.

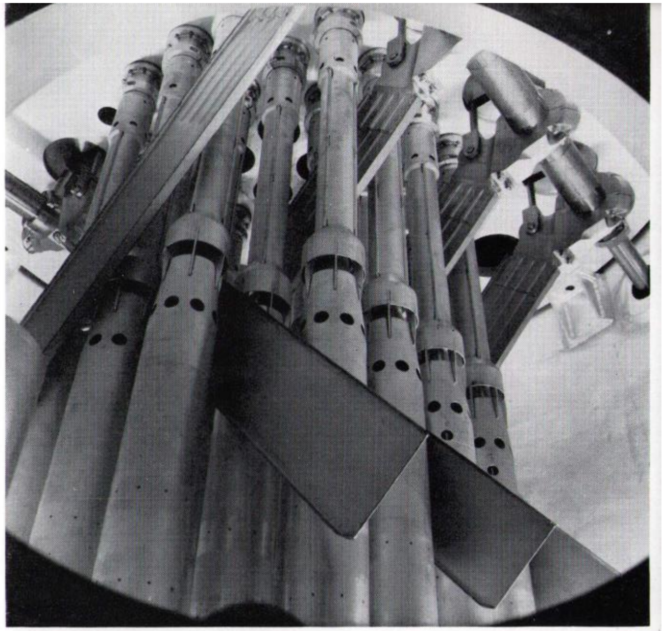
A second major establishment of the Research Group is the Culham Laboratory which is being developed nearby as a centre for research into plasma physics and fusion reactions, while ZETA (Zero Energy Thermonuclear Assembly) continues to be used at Harwell.

The Wantage Research Laboratory, some seven miles away, investigates the applications of radioactive isotopes (many of which are produced in Harwell's reactors). This work covers the development of industrial control, testing and process-study techniques (and advice to firms on their application), as well as the use of large sources of radiation both for experimental purposes and for the pre-production-scale sterilization of surgical and other products.

Research is also carried out by the Reactor Group. The Atomic Energy Establishment at Winfrith in Dorset has been built primarily for the physics and engineering work necessary up to and including the reactor experiment or small prototype system. At Winfrith, a high-temperature gas-cooled reactor, called ZENITH, went into operation in December, 1959. It is the forerunner to a reactor experiment, DRAGON, in which eleven other O.E.E.C. countries (including EURATOM) are collaborating.

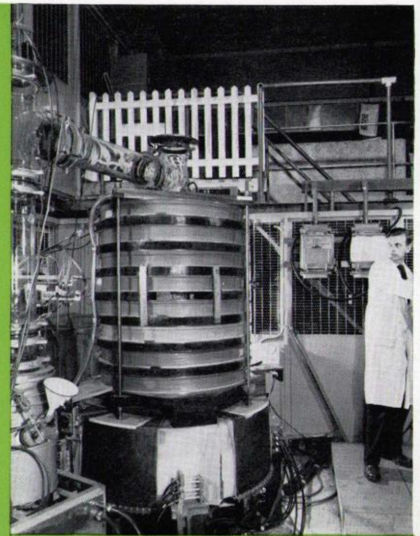
Broad range spectrograph used in connection with the tandem electrostat generator at Harwell for research on high energy particles.





A view of the core of DAPHNE reactor (Dido's and Pluto's Handmaiden for Nuclear Experiments).

FAUST, the discharge tube assembly used in thermonuclear research at Culham.



A new source of power

Most of the energy — in the form of heat — used to warm our homes, to run the factories and to produce electricity is obtained by burning gas, oil or coal.

Since the last war a new source of heat has become practicable — atomic energy. Here no actual burning occurs but energy is released by splitting the nuclei of atoms of uranium or plutonium.

There are a number of differences between this new atomic, or nuclear, method of obtaining energy and conventional fuel burning methods. The outstanding one is that very large amounts of energy can be obtained by this nuclear fission process from comparatively small amounts of matter. In theory the fission of all the atoms of one ton of uranium can release as much heat as the burning of three million tons of coal.

As yet this new atomic technology has not progressed far enough to achieve this theoretical output of energy — but one ton of uranium in the nuclear power stations already working in Britain gives as much heat as the burning of 10,000 tons of coal.

ATOMIC STRUCTURE

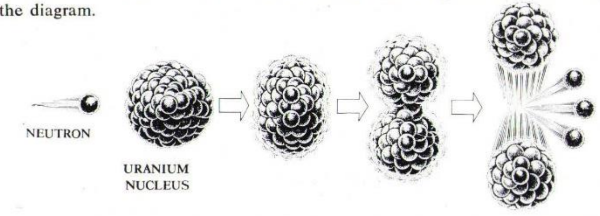
Everything is made of atoms. Over a hundred different types of atoms are known and ninety of them are found naturally on earth. Each of these hundred species of atoms, called chemical elements, has a different name, for instance: hydrogen, oxygen, iron, sulphur, etc. Most of the materials we meet in everyday life, e.g., sugar, wood, water or wool, are complex arrangements of many atoms joined together.

These atoms are very small, about a hundredth of a millionth of an inch across.

ATOMIC ENERGY

Uranium is the heaviest type of atom found on earth and is unstable. When a uranium atom is hit by a sub-atomic particle called a neutron it can split into two smaller atoms — and when this happens a lot of heat is generated and also two or more neutrons are shot out during the breaking up process.

These neutrons can be used to break up further uranium atoms and release more heat and more neutrons which can break up more uranium atoms and so on . . . This is called a chain reaction and the process is illustrated in the diagram.

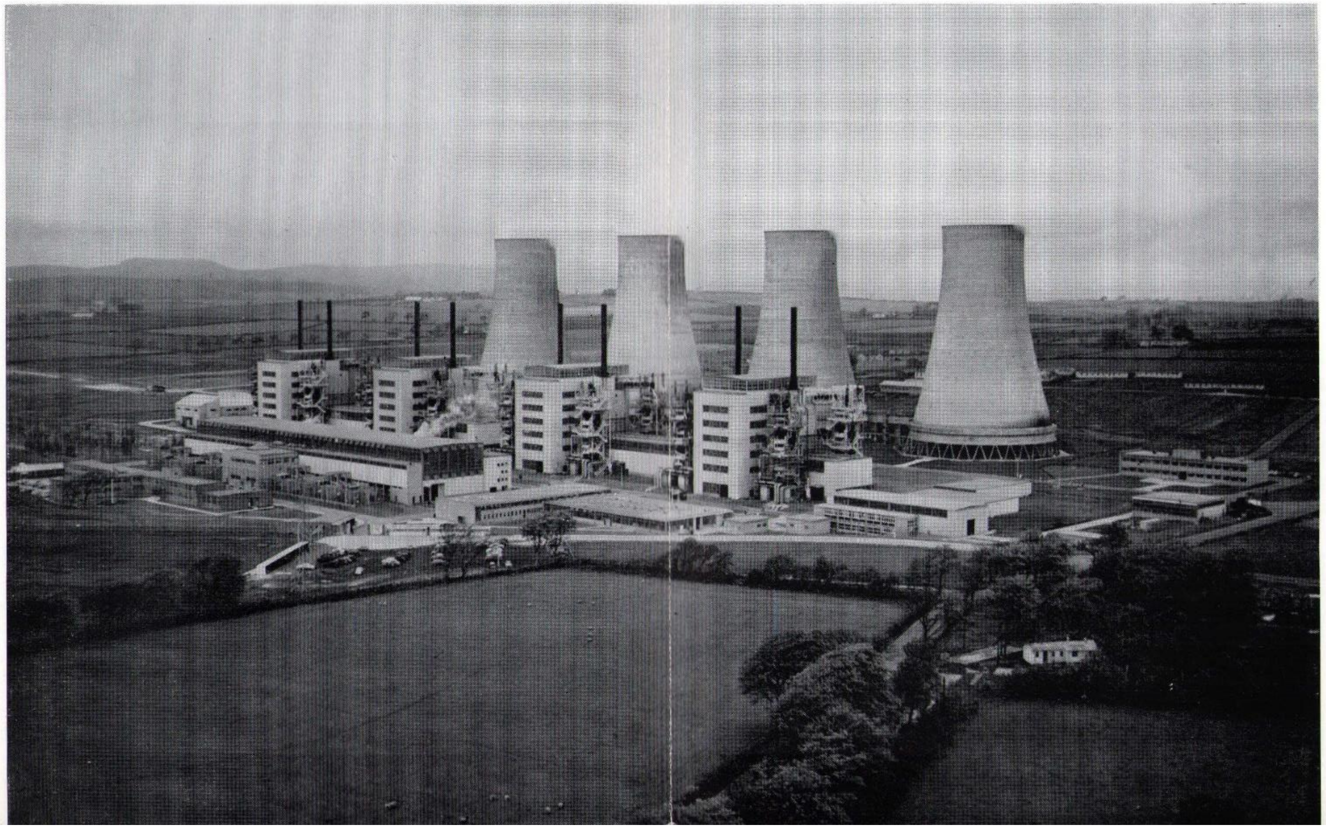


NUCLEAR REACTORS

To get heat on a commercially useful scale, millions and millions of atoms have to be split every second. This large-scale atom splitting is done in a nuclear reactor.

The reactors designed for Britain's nuclear power stations use as fuel uranium metal rods 1¼″ in diameter enclosed in magnesium alloy cans. Some thousands of these fuel elements are set in channels in a cylindrical block of pure graphite 30 to 50 feet across. This assembly of stacked uranium and graphite is enclosed in a steel pressure vessel.

When the chain reaction starts, the fuel gets hot and is cooled by carbon dioxide under pressure which passes through the channels in the reactor, out to a boiler and back through the reactor again. Steam from the boiler is used to turn a turbo-alternator which generates electricity as in any conventional power station.



Left: Chapelcross nuclear power station at Annan, Dumfriesshire.

Right: VERA reactor (Versatile Experimental Reactor Assembly) at Aldermaston.