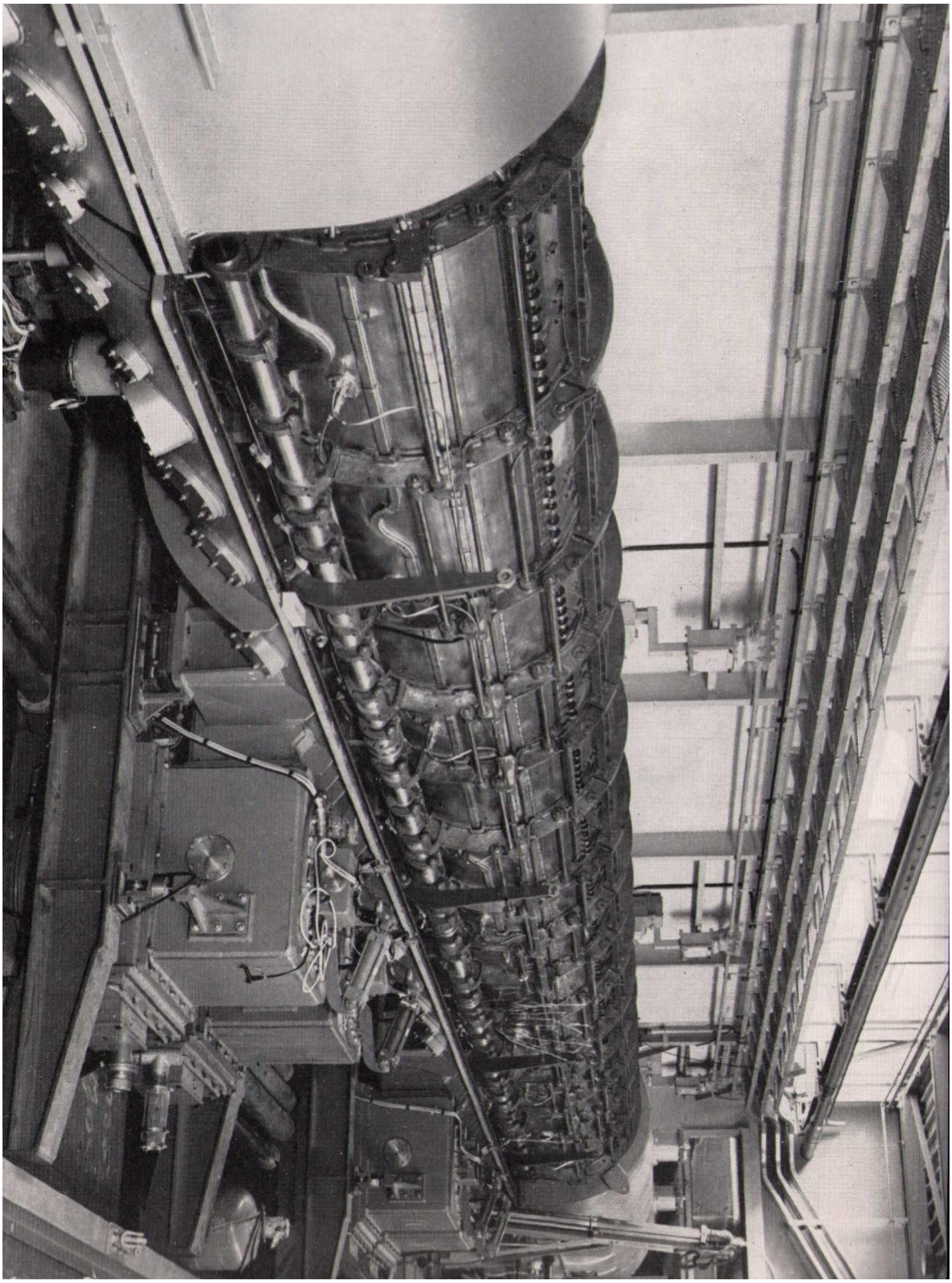
HARWELL

Careers in Nuclear Engineering



OPPOSITE: *Part of the accelerator tube of the proton linear accelerator during construction*

Careers in Nuclear Engineering

WHAT IS NUCLEAR ENGINEERING?

As knowledge increases and new fields of technology are thrown open to development so engineering must enlarge its scope. Aircraft engineers, acoustics engineers, chemical engineers, electronics engineers and control engineers are specialists who have built on the basic engineering framework a superstructure of design, manufacturing and operating experience.

Nuclear energy is another new field in which the engineer faces the challenge of creating a fresh engineering discipline. The need for a thorough knowledge of fundamental engineering principles is vital if, for example, radiation effects on materials are to be understood. To keep pace with the scientist the engineer must accept fully the tremendous implications of this new source of energy.

In this booklet the training of a nuclear engineer and the work he is expected to perform in the Research Group of the United Kingdom Atomic Energy Authority are described.

OPPOSITE: *DIDO reactor building*

The nuclear engineer

What, then, is the nuclear engineer?

Fifteen years ago, when Fermi's first pile went critical in Chicago, the nuclear engineer did not exist. When Harwell was set up in 1946 its engineers came from many traditional fields and learned their new craft as they went along. In deciding what duty a piece of metal can perform in a reactor, the engineer now has to consider how its atomic structure will change in radiation fields—whether it will become brittle, or will creep more, how many neutrons it will absorb, and how radioactive it will become. Radioactivity calculations and reactor theory are the accepted tools of his trade. It is his job to bring together the theories of the physicist and the professional skill of the engineer so that practical machines and equipment can be designed, built, operated and maintained.

The work of the nuclear engineer

As the atomic age develops more and more nuclear engineers will be needed in the construction and operation of atomic power stations and nuclear-powered ships. At the present stage of development the United Kingdom Atomic Energy Authority trains and employs many of the engineers in the nuclear field. At Harwell, headquarters of the Authority's Research Group, the nuclear engineer has two main tasks—he takes part in the research which uncovers fundamental information or leads to important new developments, and he designs, builds, operates and maintains the novel and highly complex equipment, including reactors, which make it possible to carry on the research.


150
CARBON DIOXIDE FLOW
200
250
START · RAISE

OPPOSITE: *Control panel of BEPO loop experiment with carbon dioxide gas*

THE ENGINEER'S PART IN RESEARCH

The nuclear engineer has three main tasks in the field of research. He may contribute to the basic thinking which leads to new developments, he may carry out the feasibility studies of a new reactor system, or he may design and build the equipment needed to carry out a special piece of research. The collaboration between scientist and research engineer is closest in these fields.

If we look at the development of the 'Pippa' system on which the world's first commercial power station, Calder Hall, is based, we can get some idea of the important place of the nuclear engineer. The problem of designing a nuclear plant primarily for the production of electricity was given to a team of Harwell engineers in 1951. It had been decided that natural uranium should be the nuclear fuel—beyond that nothing was laid down. Experience was limited to the building of BEPO, the Harwell research reactor, and the Windscale plutonium-producing reactors, all of which were graphite-moderated.

The use of natural uranium meant that only a thermal reactor could be designed. In this type of reactor the high-speed neutrons thrown off by the fission process are slowed down to thermal energies by a moderator. Two basic decisions had first to be taken—on the moderator and on the coolant. Mainly because it was the only suitable moderator available in quantity and because it had been used in BEPO and at Windscale, graphite was chosen for the 'Pippa' design. Improved manufacturing methods gave promise of purer graphite supplies, which would mean that a more efficient reactor could be built.

The choice of a coolant was more difficult. Liquids are good heat removers, but most react with graphite; this would make it necessary to protect the graphite channels with metal linings. Most

NEPTUNE zero-energy reactor: the inside of the reactor after the top shielding has been removed and the water moderator drained off liquids and metals also absorb neutrons appreciably. Since only natural uranium was available, minimum neutron losses were essential, so a gas coolant, with its low neutron absorption, was chosen.

The next stage was to choose the coolant gas. Carbon dioxide looked the most promising, particularly as it was available in quantity and was not a strong neutron absorber. Two matters were in doubt, however—what would be the effect of high temperatures on carbon dioxide, especially under radiation, and would it react with the graphite and so affect the structure of the moderator? For answers to these questions the engineers turned to the Harwell chemists.

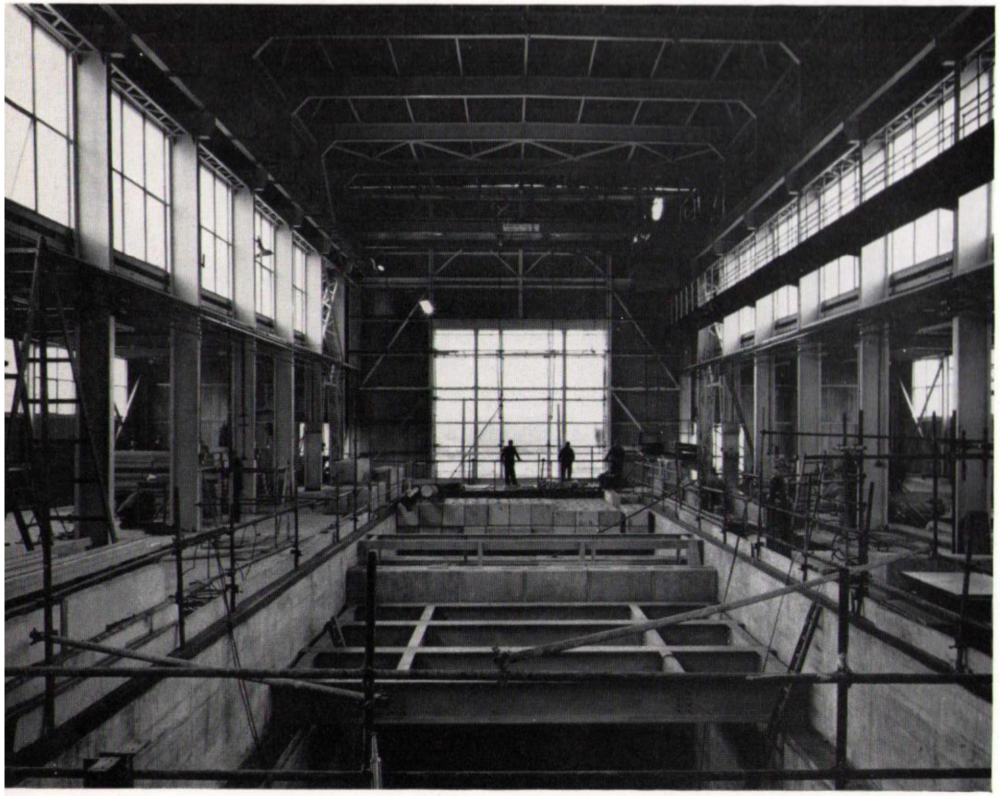
The answers were reassuring. Special measurements, which in themselves set some intricate engineering problems, were carried out in BEPO, and it was shown that although both the structure of the gas and its reaction with graphite were affected, the overall result would not be detrimental to the operation of the reactor.

The feasibility team was now in a position to calculate the overall core size of the reactor and the quantity of fuel needed for different arrangements of the fuel elements. The neutron absorption of fuel, can, moderator and coolant had to be considered, together with the rate of heat transfer from fuel elements to cooling gas under various pumping conditions. In addition, calculations on steam utilisation were made by firms with suitable experience so that the best ratio between plutonium production and electricity generation could be chosen.

Important engineering problems were raised by the design of the fuel element and its can. Leaving aside the complications which result from the peculiar structural behaviour of uranium under radiation, the design of a can is still extremely complex. The neutron absorption of the material must be weighed against mechanical strength, and its heat transfer properties must be of the highest order. Good thermal contact must be maintained between fuel and can. Little was then known about the effect on heat transfer of different sizes and shapes of fins in the longitudinal flow conditions of a reactor channel, and experiments at different temperatures and pressures with various types of fin had to be carried out.

In 1952 engineers from the Central Electricity Authority and from private firms were called in to tackle problems in the more conventional areas of the design—the electrical equipment, gas circuits, civil engineering aspects, heat exchangers and the pressure vessel in which the reactor would be contained. With their help the feasibility team established that a nuclear power station which would also produce plutonium was an economic possibility.

A zero-energy building at Winfrith showing the pit for the ZENITH reactor



From there the Authority's Industrial Group, with continuing advice and assistance from Harwell, took up the responsibility of building at Calder Hall the first plant of its type in the world.

With the completion of these studies, which led to the adoption of the gas-cooled reactor as the basis for the first stage of the country's nuclear power programme, Harwell engineers were able to turn their attention to wider fields. Ideas for a new high-flux research reactor were examined; from these crystallised the proposals for DIDO and PLUTO, which have now been built and are operating at Harwell. Several 'zero-energy' reactors which are used as tools by the reactor physicist have been designed and constructed. NERO, a reactor for investigating the characteristics of advanced graphite-moderated systems, is one of these.

ZENITH, a further unit for special physics tests at very high temperatures, is now being built at the Research Group's new site at Winfrith in Dorset. With the new information supplied by the ZENITH reactor, the project engineers will be in a position to design a reactor experiment of perhaps 10 MW output in which heat transfer and metallurgical problems can be studied together. A reactor experiment is an essential stage in the development of a full-size power reactor and its operating characteristics begin to resemble those of the reactors which will eventually be installed in nuclear power stations.

In an exploration of advanced reactor systems, gas-cooled systems operating at temperatures high enough to operate gas turbines and water-cooled systems for special applications are being examined critically. Liquid fuels are being investigated to see if they can be used to reduce fuel processing costs.

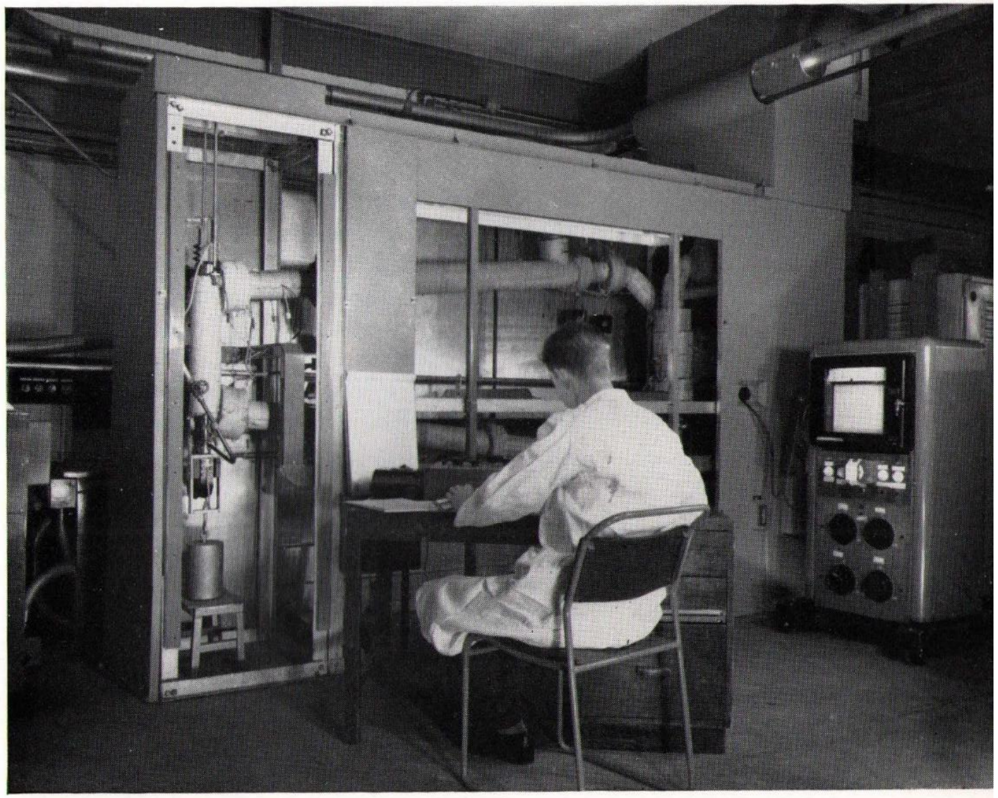
The Engineering Laboratory

It is not enough to do design studies of reactor systems. Research and development must be carried out in the engineering field as well as in chemistry and metallurgy. The programme of the Engineering Laboratory at Harwell offers excellent opportunities to the engineer who is inclined more to research and experimental work.

It was here that the initial work on methods of improving heat transfer from fuel cans for the Calder Hall reactors was done. At present under study are certain aspects of the mechanism of heat transfer to water at very high rates, where the heating surface may be above the boiling point though the bulk of the water is well below. The hydrodynamic differences between slurries and true liquids are important in the examination of slurries as possible reactor fuels.

Liquid metals, of great interest because of their good heat-transfer properties, pose problems in

Heat-transfer experiment on organic liquids



techniques. Circuits containing them must be leak-free, scrupulously clean internally, and have local temperatures carefully controlled to avoid freezing-up. Technological investigations such as these form another interesting facet of the laboratory work. Instrumentation has to be evolved which, for example, will permit remote readings to be taken in radioactive circuits, or which, like electro-magnetic flowmeters for liquid metals, take advantage of any unusual and useful properties a novel coolant may possess.

In many cases special pumps and other components have also to be developed. The Laboratory has investigated the basic design parameters of electro-magnetic pumps for liquid metals. Mechanical pumps which run on gas bearings have been developed to run totally enclosed without glands so that active liquids can be handled without fear of leakage, and contamination of the liquid being pumped can be prevented. Other totally enclosed units in which the motor runs immersed in the fluid are also being tried, and this has involved further investigations of bearing design and bearing materials.

The range of problems met with is a wide one. The ingenuity and resourcefulness of the engineer, as well as his fundamental knowledge, are thoroughly tested by this work.

Chemical engineering

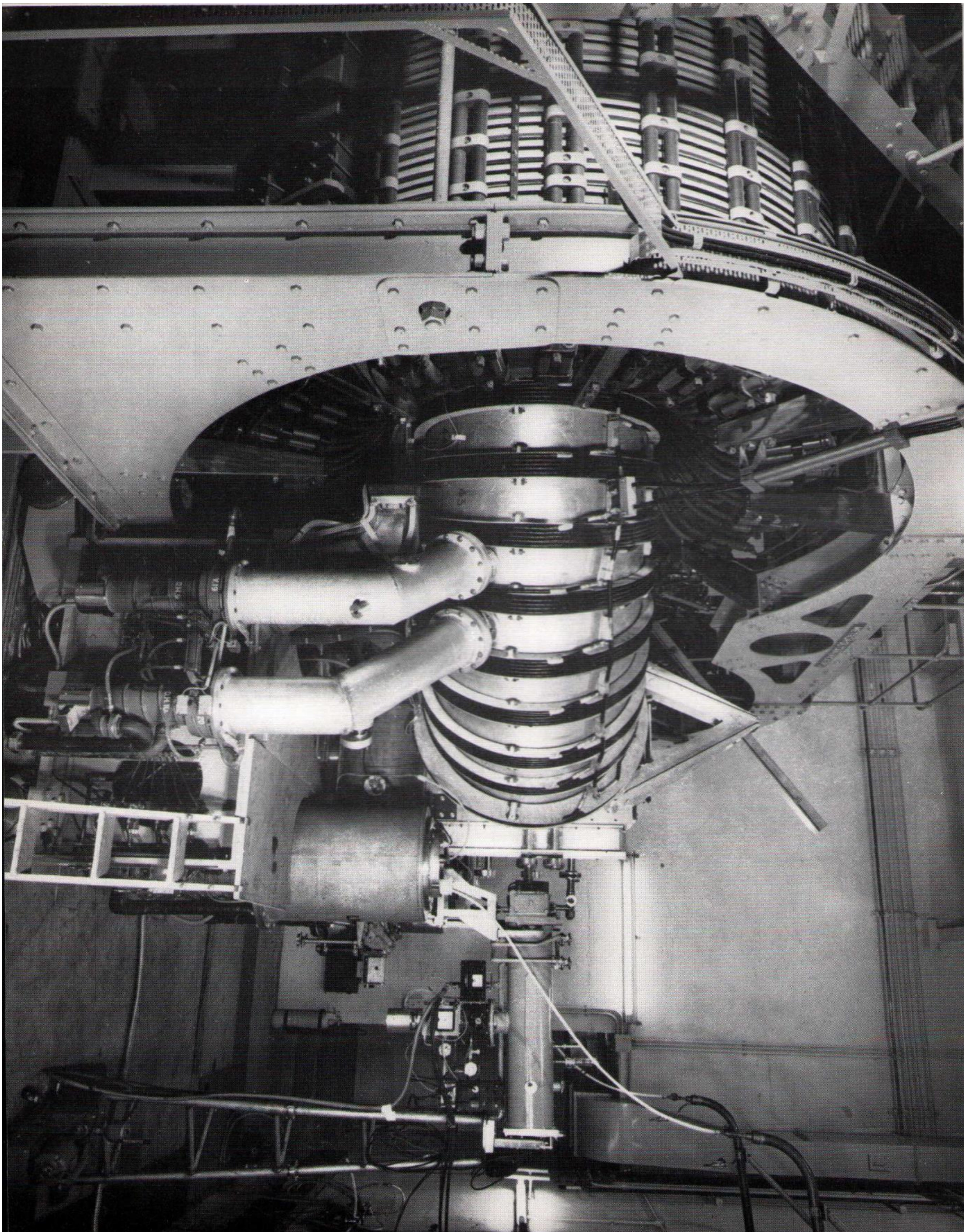
The nuclear engineer is concerned with providing the special materials required in the construction of a reactor as well as with its design and development. He must also arrange for the treatment and disposal of these materials after irradiation in the reactor. The many calls on the special skills and experience of the chemical engineer are reflected in the work carried out in the laboratories of the Chemical Engineering Division.

In some fields the work is complementary to that in the Engineering Laboratory—for example, in the study of the basic technology of slurries which may be used in the core of a homogeneous reactor or in its blanket, or in the study of coolants such as two-phase mixtures of gases and liquids and organic liquids.

The ancillary equipment of reactors—for example gas cleaning and scrubbing plant, and water treatment plant—presents special design problems. Development work must be undertaken and this calls for substantial experimental equipment for operation at high pressures and temperatures. This kind of work frequently brings together working teams of chemical and mechanical engineers, chemists and metallurgists; so that there is a healthy cross-fertilisation of ideas between the different disciplines.

The chemical engineer has a specially important part to play in the development of processes—for the production of heavy water or new and improved types of graphite, for the treatment of irradiated fuels, or for the disposal of radioactive fission products. The translation of processes from the bench into engineering plant presents many interesting problems in fields where design information is scanty or even lacking. In addition to process development there is the need to improve design methods. The Division has made notable contributions in solvent extraction and is now examining certain aspects of fluidisation from this point of view. Economics are also important since they may control the choice of routes and influence the direction of development. In the process field especially the chemical engineer finds economics a fascinating challenge to his design study and appraisal work.

Not all chemical engineers look for a career in research and development, but a graduate who enters this Division need not fear that he has committed himself for life. There is no doubt that a few years in research work provide a firm foundation in technology, economics and safety for a later career in design or operations.



OPPOSITE: *General view of ZETA*

ENGINEERING THE RESEARCH PROGRAMME

The Harwell engineer also has an important part to play in support of the research scientist. He does this by designing, building, operating and maintaining three main types of equipment—the enormously complex research machines found at Harwell, the remote-handling gear needed to deal with highly radioactive materials, and the reactors built as research tools rather than as zero-energy experiments to test particular forms of reactor design.

Controlled thermonuclear research

The major experimental machine at Harwell for research into controlled thermonuclear reactions is ZETA. ZETA is a device for passing currents of hundreds of kiloamperes through an ionised gas inside a toroidal discharge tube. Neutrons resulting from the fusion of deuterium ions were first observed on 30th August 1957, but it has been established that these were largely due to a non-thermonuclear process. More neutrons were produced than could be accounted for by the calculated reaction rate for deuterium at the observed temperature of up to five million °C—nearly a thousand times hotter than the surface of the sun. Since then engineers have carried out considerable modifications to ZETA to improve the reliability of operation and to allow much higher currents to be achieved.

ZETA has used engineering techniques up to the limit of existing experience. To investigate controlled thermonuclear reactions it is necessary to develop new techniques and in the Development Laboratory there are investigations into methods of

OPPOSITE: *Working face of the high-activity handling cells*

energy storage, problems of high power switching, magnetic field problems and materials and constructional methods for discharge tubes. The design of systems to meet the requirements of theoretical proposals for improving the stability of the discharge channel presents the engineer with many technological problems.

There are many other challenging problems facing the engineer and the physicist before the virtually unlimited power source of deuterium (from water) can be effectively utilised through a controlled thermonuclear reaction.

Research reactors

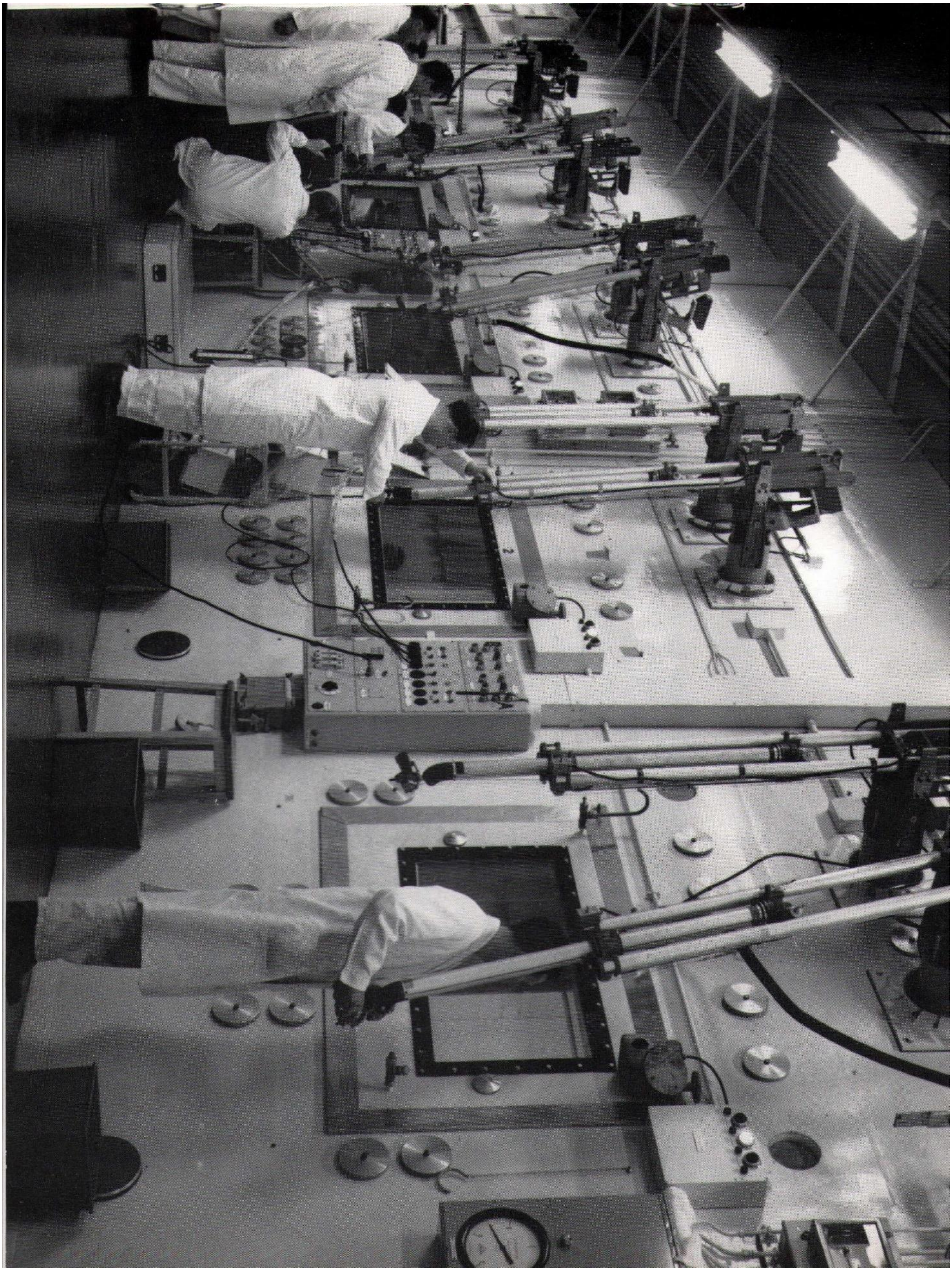
There is considerable scope, particularly for the man trained in mechanical engineering, in the building and running of the reactors used as research tools. DIDO and PLUTO, the high-flux materials-testing reactors which also produce radioactive isotopes, were designed and built by a Harwell team. They have enriched uranium cores and use heavy water both as a moderator and as a coolant. LIDO, the 'swimming pool' reactor, uses enriched uranium fuel, and ordinary water as coolant and moderator. It, too, was built under the supervision of Harwell staff. The intense radiation given out by a reactor in operation means that a 'shield' (usually concrete and steel in land reactors) must be built to protect personnel. The main part of LIDO's programme is devoted to study of shielding problems.

The major research reactors at Harwell are BEPO, DIDO, PLUTO and LIDO. All these reactors are operated and maintained by engineers in the Reactor Services Group and they provide an invaluable training ground for the nuclear engineer.

The experimental work in a research reactor is closely bound up with its operation, and operations staff must clearly understand the purpose behind all experimental rigs. The complexity of the experiments which are built into it mean that quite large numbers of skilled staff are involved. The operations engineer gains experience in his professional field, which will stand him in good stead if he moves on to reactor design work. He also acquires managerial experience through the control of professional and technical staff and skilled craftsmen.

Reactor loop experiments

Experiments into radiation and other effects are carried out by introducing 'loops' into Harwell reactors. For example, a replica of one of the Calder Hall reactor channels was built into BEPO and subjected to the same conditions as it would experience in the Calder reactor. This provided the designers with invaluable information about the reactions between carbon dioxide and graphite



under Calder conditions. In another loop liquid metal is pumped through the reactor and round a closed circuit to study the effects of radiation on the compatibility and stability of the fuel, the structure and the coolant. Yet another loop contains water at 2,000 pounds a square inch. Loops of this kind are reactor systems in miniature and their design, construction and operation are fascinating tasks for the engineer, with many novel features.

Remote-handling equipment

The high levels of radioactivity of much of the material withdrawn from reactors mean that it must be handled by remote control from behind shielding walls of lead or concrete. The scientist who wishes to process a 'hot' metal sample or examine the changes induced by radiation in a specimen depends on the engineer to give him ingenious mechanical substitutes for his own skilled fingers.

A comprehensive range of remote-handling equipment is to be found in Harwell's new High Activity Handling Building. This building contains a number of 'hot cells' which have concrete shielding walls and windows five feet six inches thick. These cells are equipped with remote-handling devices and remotely operated machine tools and equipment. With this plant the engineer can offer to the scientist a service for the examination and machining of intensely radioactive material. The provision of remote-handling and viewing equipment is the prime task of the engineers of the Remote Handling Development Section at Harwell.

Particle accelerators

Studies of the structure of the nucleus depend on experiments into the interactions between nuclei and elementary particles. To conduct these experiments the nuclear physicist uses particle accelerators of very advanced types; three important new research machines are now being built at Harwell.

One of these consists of two 6 MeV electrostatic generators in tandem; particles are accelerated in the first half of the machine as negative ions which are then 'stripped' at the intermediate high-voltage terminal to give 6 MeV positive ions for acceleration up to a total energy of 12 MeV in the second half of the machine.

A 50 MeV proton linear accelerator is under construction, and shortly a 'neutron booster', which produces intense beams of neutrons in pulses by the direction of an electron beam from a 28 MeV electron linear accelerator into a uranium 235 target, will be commissioned.

7 GeV proton synchrotron

To understand the properties of fundamental particles one of the most fruitful methods of attack is the study of interactions involving ultra-high energy particles.

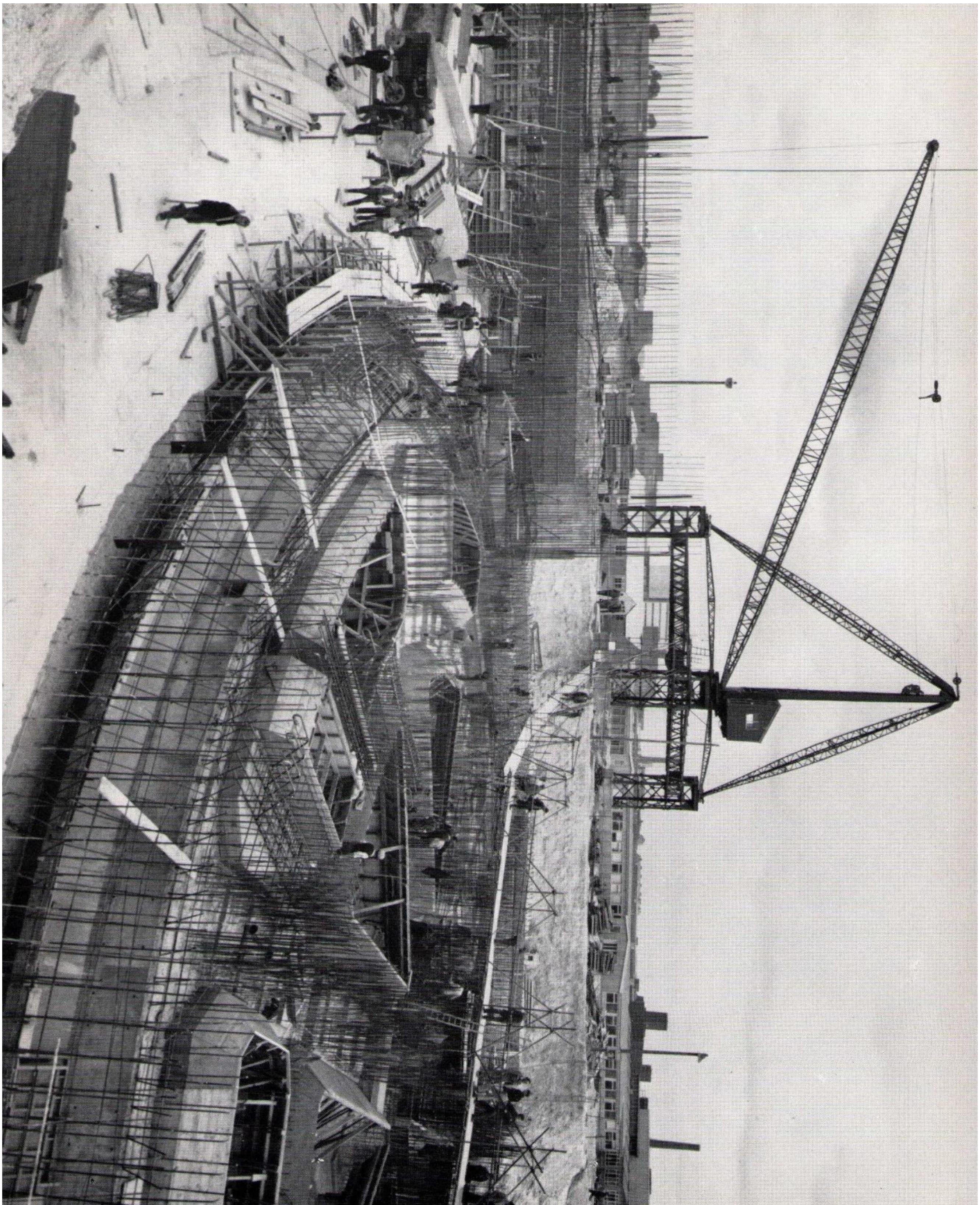
At the Rutherford Laboratory adjacent to Harwell the National Institute for Research in Nuclear Science is building a seven thousand million electron volts proton synchrotron which will give a beam intensity several thousand times greater than the highest energy at present available in the United Kingdom.

The design consists essentially of a ring-shaped electro-magnet, 150 feet in diameter and containing 7,000 tons of steel, a 15 MeV linear accelerator for injection, and the necessary power supplies and buildings.

The magnet power supply consists of two induction motors each of 5,000 h.p. each driving a 60 MVA generator to which is coupled a flywheel of about forty tons weight. In all, four machines and two flywheels will be mechanically coupled together to make a combined set about 110 feet long. The generators are A.C. machines which supply through transformers a bank of grid-controlled mercury arc rectifiers.

The ring-shaped electro-magnet has a magnetic field arranged to confine the particles to a constant radius within the centre of a large vacuum vessel located between the poles of the magnet. At one point or more on the circular path a radio frequency accelerating field provides increments of energy.

Protons are injected into the synchrotron from the 15 MeV linear accelerator at a point near the outer circumference of the synchrotron when the rising magnetic field has reached the value appropriate for their energy. The particles are then accelerated at a rate necessary to keep the equilibrium orbit near the centre of the vacuum chamber. After several million revolutions during which energy has been gained the particles are brought to bear on a target.



OPPOSITE: *Construction of the magnet monolith for the 7 GeV proton synchrotron*

Massive shielding is needed around and over the magnet room to protect staff from radiation, and the large experimental area near the synchrotron is separated from it by a concrete wall 28 feet thick. Beams of particles are admitted into the experimental area through channels in this shielding wall. The contours of the site have been exploited to ensure that the most intense particle beams are driven into a hillside and come to rest far underground.

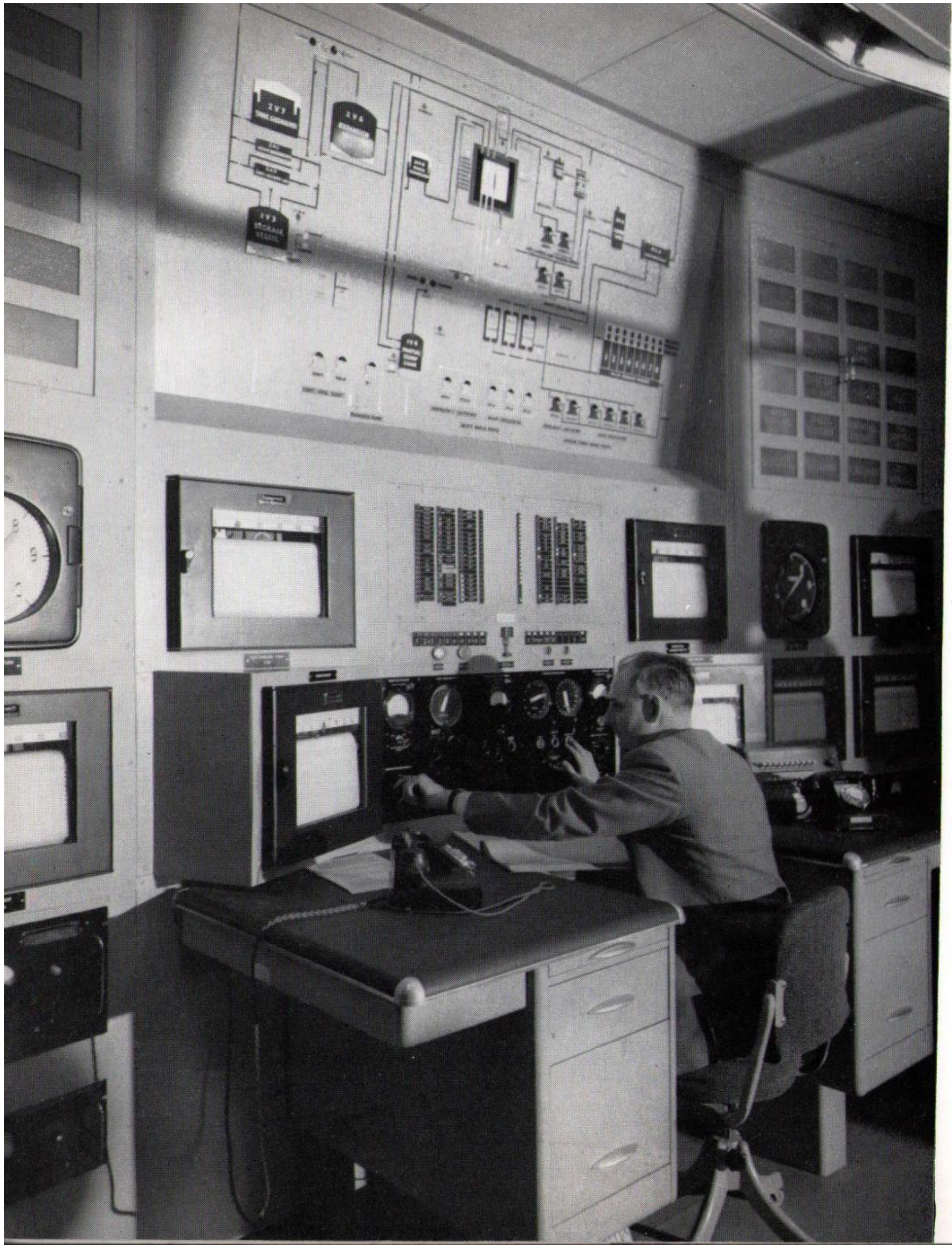
Following the first proposals for the design of the proton synchrotron by the physicists and the specification of requirements by mechanical and electrical engineers, the construction demands a large-scale effort in civil engineering to house the special plant involved. The photograph shows the construction of the magnet monolith.

Electronics

Most of the research and development carried out at Harwell involves the detection and measurement of nuclear particles and radiations. Electronic techniques provide almost the only means of performing this and are needed also for many other functions, so it is hardly surprising that electronic instruments and systems are much in evidence almost everywhere at Harwell. They are vital for controlling nuclear reactors and for studying their behaviour, for protecting workers against excessive exposure to nuclear radiations, and for research work in the chemical and metallurgical fields. In nuclear physics research, the equipment for many experiments consists basically of large and complicated electronic systems.

Nuclear experiments using the new high-energy particle accelerators are capable of providing information at a great rate, and in order to make best use of the time of these expensive machines this information must be analysed and recorded very rapidly by specialised electronic data-handling systems and special-purpose electronic computers. Work on controlled thermonuclear reactions depends on the use of very advanced electronic techniques for the detection, measurement, recording and analysis of a wide variety of physical quantities.

Moving forward the frontiers of knowledge in these fields of research depends so often on electronic techniques that there is a constant need to



Control room of the DIDO reactor

refine them and to introduce new ones. The Electronics Division has the task of studying and developing electronic techniques likely to be of value in the research and development carried out at Harwell and applying these techniques effectively. This involves close contact with, and often participation in, very many of the Research Group projects, so as to be able clearly to understand the problems involved and to contribute effectively to their solution.

Important contributions have been made at Harwell to the application of transistors and special magnetic devices, to the theory and practice of controlling nuclear reactors, to the study of very high-speed pulse circuits and to the development of nuclear radiation detectors using gas discharges and scintillating crystals, to mention only a few examples. In addition a great deal of electronic instrument development work is carried out in close collaboration with the electronic industry.

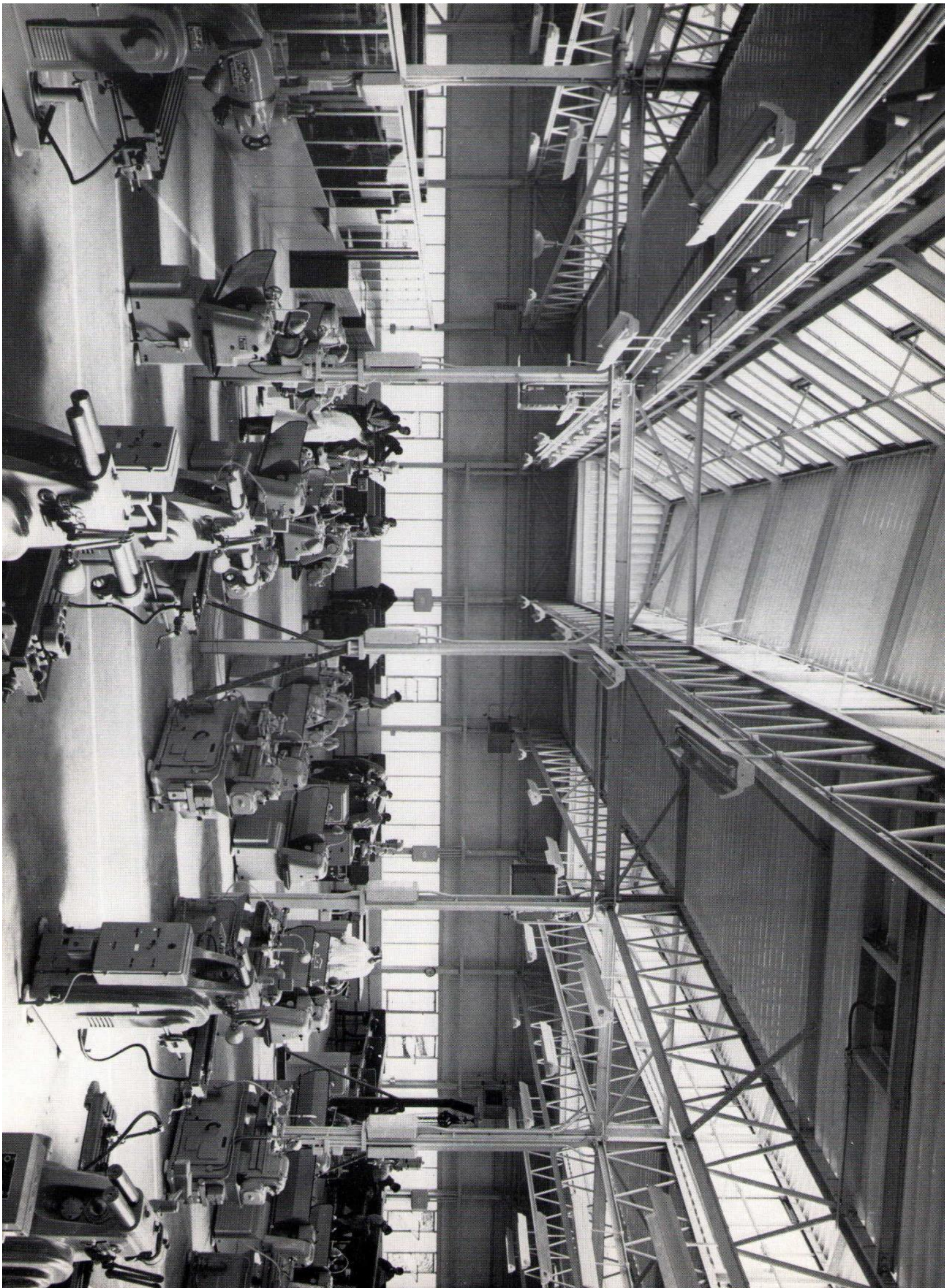
Work in this field calls for a training in either physics or electrical engineering and there is a great advantage in having at least some knowledge of both.

TRAINING FOR NUCLEAR ENGINEERS

The graduate engineer who wishes to make a career in the nuclear engineering industry must be prepared to obtain during the first years of his career an understanding of the theoretical basis underlying the demands made by atomic energy on his particular technology, whether it be chemical, electrical, electronics or mechanical engineering. All these branches of engineering are required for the advancement of an industry which uses fuels and materials of a very high purity, in which very large high-voltage accelerating machines are used as research tools and the latest methods of automation and control are axiomatic. Above all the engineer strives to use equipment in novel conditions reliably, safely and economically.

The final question to be asked in the chain of research and development by which advances are made in this industry is 'Can it be engineered?' The engineering feasibility of a project must be studied at as early a stage as possible; the engineer and the scientist with whom he studies the problem must have a community of understanding. To this sharing of ideas he must, however, bring not only a thorough knowledge of theory, but also an understanding of the long-established principles of practical engineering.

Engineering work in the Research Group of the United Kingdom Atomic Energy Authority gives the young engineer unique chances to obtain this understanding of the principles of nuclear science. He is able, by attending colloquia and lectures and by being part of the research team, to keep abreast of the latest technologies. In his own field he will be concerned with formulating and assessing the engineering problems as they emerge. He will also be able to practise and study operating and handling



OPPOSITE: *Apprentice training shop at Winfrith*

techniques associated with the most advanced plant and materials in use in the industry and the problems of management and safe operation which form an important part of a senior engineer's job.

The training schemes evolved by the Engineering Division take advantage of the fact that many aspects of nuclear engineering are involved in the course of its contribution to the work of the Research Group. The Division itself is a very large engineering organisation which employs several hundred professionally qualified engineers. There is a formal training scheme for Graduate Apprentices: graduates are also accepted for training as Technical Assistants and Scientific Officers.

The training of all apprentices and junior engineers is controlled by a Board of senior engineers of which the Engineer-in-Chief is Chairman. There are generous concessions for further study, including a course at the Harwell Reactor School, and graduates are encouraged to obtain post-graduate qualifications.

Graduate Apprentices

The Graduate Apprenticeship Scheme is a two-year course open to honours graduates and post-graduate students in electrical, mechanical, electronics and chemical engineering who wish to obtain practical experience in order to qualify for membership of an engineering institution. The course can also be adapted to accommodate graduates in associated sciences who wish to prepare by a practical training for a career in nuclear engineering.

The first year's practical training is usually taken at the works of a large manufacturing organisation where the most modern methods of large-scale fabrication, erection and construction can be studied. The second year is spent at Harwell in sections appropriate to the apprentice's academic training and career aspirations. By these means a very flexible training can be given. A sample programme for a mechanical engineer in the reactor field is shown overleaf. These training courses have the approval of the senior professional engineering institutions and can be modified for men who have had suitable practical experience.

When he completes his apprenticeship the graduate apprentice may be considered for employment with the Authority as a Scientific Officer or as a Technical Assistant or may seek further experience elsewhere.

Technical Assistants

Honours graduates in engineering or trainee engineers with suitable qualifications and ability

An example of the Research Group Graduate Apprenticeship Scheme

The course is adjusted to suit individuals. This example is for a mechanical engineer

FIRST YEAR at a selected industrial firm

1st Month
Heavy Engineering

2nd Month
Pattern Shop

3rd and 4th Months
Fabrication

5th Month
Tinsmiths

6th Month
Foundry

7th and 8th Months
Annual Leave
Steam Turbine Design

9th and 10th Months
Engineering Laboratory

11th and 12th Months
Commissioning of Engineering Plant on Site

SECOND YEAR at Harwell

1st, 2nd and 3rd Months
Operation and Maintenance of Nuclear Reactors and Associated Engineering Plant

4th, 5th and 6th Months
Design, Test and Commissioning of Experimental Equipment used in Nuclear Reactors

7th and 8th Months
Manufacture of Experimental Rigs

9th Month
Annual Leave

10th, 11th and 12th Months
Reactor Design in Drawing Office, Compiling Specifications and Site Engineering during Construction

who have already completed a recognised apprenticeship may enter the Authority as junior engineers in training in the grade of Technical Assistant.

After approximately a year spent in gaining general experience a Technical Assistant is employed as a fully responsible junior engineer in project, design or operation sections appropriate to his branch of engineering and the career prospects envisaged by him. His service can then be recognised by the senior engineering institutions as qualifying for Associate Membership.

Scientific Officers

First or good second class honours graduates and post-graduate students may be appointed as Scientific Officers in the Engineering Laboratory or the Chemical Engineering or Electronics Divisions. Scientific Officers are expected to show promise of research ability and the capacity to lead or participate in fundamental research activities. Graduates will be given whatever training in research methods and techniques they need and will be encouraged to make studies of reactor theory by attending the Harwell Reactor School.

Vacation Students

Undergraduates and post-graduate students who have not completed their university studies may work at Harwell during the long vacation. Students are generally accepted for a period of eight weeks and during this time are engaged on practical work in some facet of Harwell engineering which is a useful supplement to the student's academic programme. Examples of the type of work which can be undertaken by a vacation student are given in the programme for the second year of the Graduate Apprenticeship Course on the opposite page.

A vacation course gives good opportunities to become familiar with the engineering work at Harwell and with Harwell itself. Vacation students are paid a weekly expense allowance sufficient to cover the cost of their accommodation and day-to-day expenses. Accommodation can be arranged for students whose homes are at a distance from Harwell.

Boat-building and sailing: two activities of the Sailing Club, one of the many Research Group clubs and societies

THE AUTHORITY AND THE RESEARCH GROUP

The United Kingdom Atomic Energy Authority was set up by Act of Parliament in 1954 as a public corporation to take over from the Ministry of Supply executive responsibilities for the co-ordination of all technical aspects of atomic energy including responsibility for weapons research and for the supply and stocks of atomic fuels and materials. The Authority has wide powers for the initiation of internal and extra-mural research and for the organisation of its work and staffing policies.

Staff gradings are common throughout the Authority and interchange of staff between Groups is encouraged by making staff vacancies open to all suitably qualified officers of the Authority. Transfer and removal allowances are paid when an officer moves his home as a result of such a transfer.

The three groups of the Authority are:

Industrial Group

The headquarters of the Group are at Risley in Lancashire and its Managing Director is Sir Leonard Owen. The Group also has establishments in the north of Britain, at Springfields, Capenhurst, Windscale, Calder Hall, Chapel Cross and Dounreay. Its responsibilities include the design, construction and operation of plants for nuclear fuel extraction, fabrication and chemical processing, and of the reactors at Windscale, Calder, Chapel Cross and Dounreay.

Weapons Group

The Group has its main research establishment at Aldermaston under the direction of Sir William Penney, with proving establishments at Shoeburyness and Foulness. This Group is responsible for the atomic defence research programme.

Research Group

The headquarters of the Group are at Harwell in Berkshire. Dr. Basil Schonland has been appointed Director in succession to Sir John Cockcroft, under whom Harwell became one of the leading research establishments in Europe.

The Group is concerned with basic nuclear research, both fission and fusion, and with the development of industrial and research applications of reactors, massive sources of ionizing radiations and radioisotopes.

The work of the Research Group is carried on in close co-operation with industry and engineers from many firms are attached to engineering groups at Harwell and participate in their work. Staff from University Research Departments often give assistance on a temporary basis to the work at Harwell.

Atomic Energy Research Establishment, Harwell

There are 6,000 people employed at Harwell and of these about a quarter are graduates or possess professional qualifications. In many aspects of its organisation and in its atmosphere Harwell is similar to a university. The research divisions into which it is organised are comparable in size to university departments, and the status of a Division Head is similar to that of a university professor.

There are excellent library and information services at the Establishment and lectures, colloquia and conferences are held in the Cockcroft Hall. Staff are encouraged to attend outside lectures and courses and to publish in appropriate journals.

Harwell is situated mid-way between Oxford and Newbury, 14 miles from each town on the main road between the two. It is six miles from Didcot, from where there is a good main line service to London, 53 miles away.

The Establishment itself provides opportunities for many leisure activities in addition to those in the neighbouring towns. The sports clubs and other societies cater for a very wide range of active and intellectual interests and are well supported. There are hostels on the site and in Abingdon providing accommodation for single people, and the Establishment owns houses in Abingdon, Wantage and Wallingford. Transport is provided from these and the other main towns in the area, including Oxford and Reading.

The Establishment has two subsidiary branches, one of which is at Wantage where the laboratories of the Technological Irradiation Group (part of the Isotope Division) are situated. The second is the Radiochemical Centre at Amersham, near High Wycombe in Buckinghamshire, which processes and sells naturally occurring radioactive isotopes and complex labelled compounds.

Atomic Energy Establishment, Winfrith

Because of the expansion of the work at Harwell it has become necessary to set up the Atomic Energy Establishment at Winfrith Heath in Dorset, and it is under construction now. Low-power reactors will be built there to study the behaviour of reactor systems considered to be promising lines of development. The first of these will be in use in 1959.

The main staff expansion is starting in 1959 both by direct recruitment and by transfer from Harwell. Graduate engineers recruited to the Research Group may complete their training either at Harwell or at Winfrith, in order to give them a balanced training adjusted to suit individuals. Facilities at Winfrith will complement those existing at Harwell.

Winfrith is eleven miles from Weymouth, eight from Dorchester, sixteen from Poole and twenty from Bournemouth.

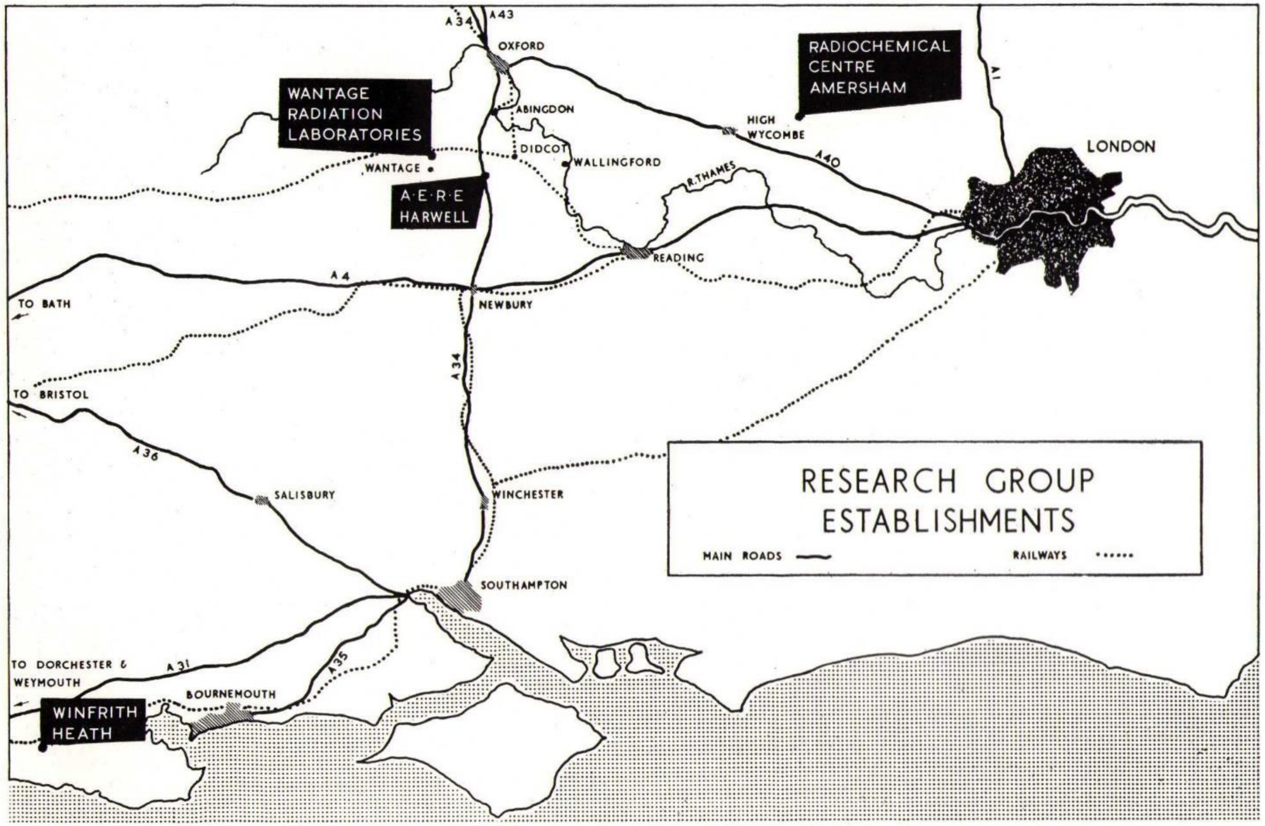
Part of one of the Authority's housing estates at Abingdon

FURTHER INFORMATION *about opportunities in Nuclear Engineering may be obtained from:*

The Group Recruitment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks

FRONT COVER PICTURE: *The tandem Van de Graaff generator in course of erection at Harwell*

BACK COVER PICTURE: *Harwell from the Ridgeway with reactors* ***PLUTO, LIDO*** *and* ***DIDO*** *in the foreground*



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