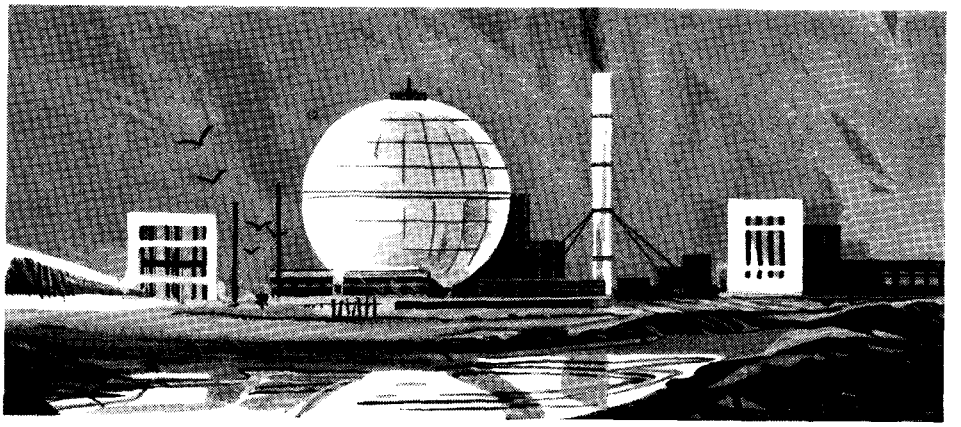
ATOM

Number 156 / **October 1969**

MONTHLY INFORMATION BULLETIN OF

THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY



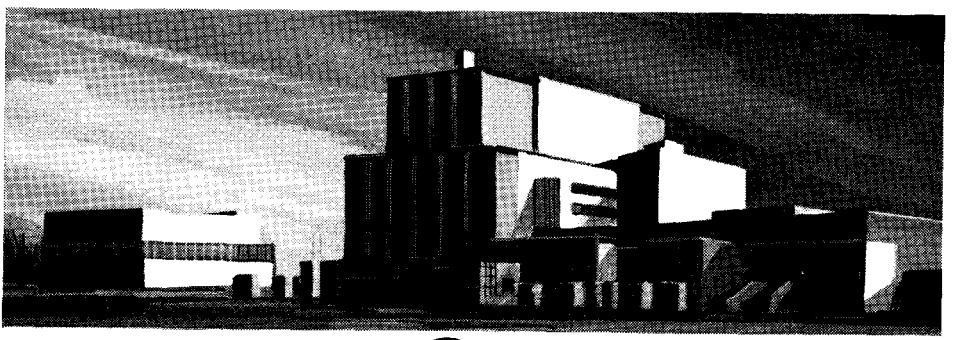
From

DOUNREAY to HUNTERSTON 'B'
JOHN THOMPSON

have unrivalled experience in nuclear power

John Thompson's long background in nuclear design, manufacture and site construction includes contracts at Berkeley, Dungeness 'A' and Oldbury Magnox stations, at Hinkley 'B' and Hunterston 'B' AGR stations, and at Dounreay and Winfrith Heath. This wide experience ensures that the company is in the forefront of design and development work for future nuclear reactor systems, such as the High Temperature Gas Reactor and the Sodium Cooled Fast reactor.

John Thompson—suppliers of reactor pressure vessels, boilers, water treatment plant, ducting diagrids, pipework and other associated equipment to the nuclear industry.



JOHN THOMPSON GROUP

JOHN THOMPSON LIMITED . WOLVERHAMPTON . ENGLAND
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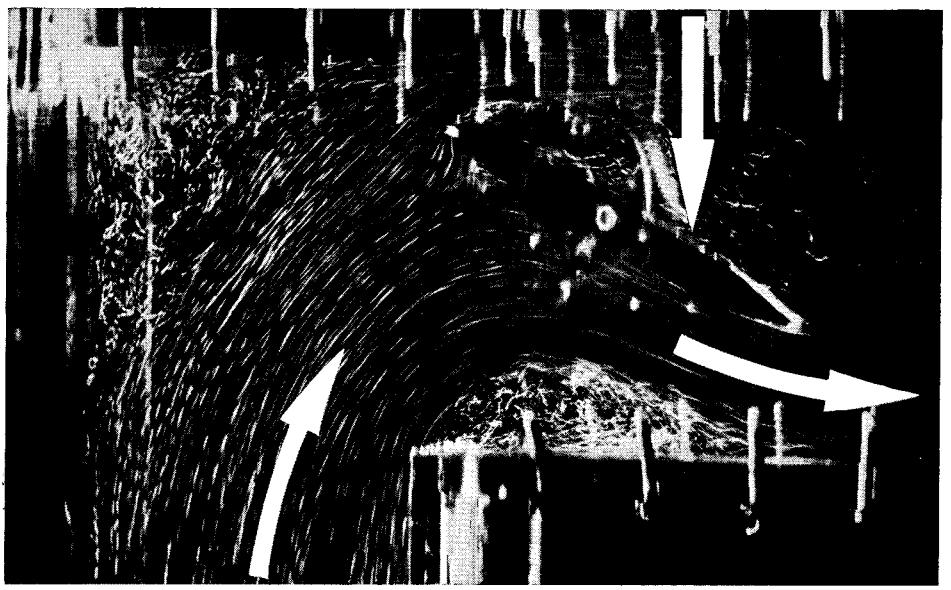
DC/NP1 rb

LUCAS ENGINEERING LABORATORIES, BURNLEY



Flow visualisation by Lucas

Using a transparent 1/12th scale model of the Dounreay Prototype Fast Reactor, in conjunction with a water flow analogue, Lucas engineers have worked in close collaboration with U.K.A.E.A. to study local flow regimes in the primary circuit, pump intakes and cooling circuits giving the unique opportunity to get into the heart of the reactor and understand local flow conditions not possible in the actual plant.

The flow visualisation technique has been developed over the years by Lucas, and has been extensively used in fuel element design and development, and in the study of liquid, gas and air flow in a variety of applications.

The photograph shows the flow patterns associated with the valve for the S.G.H.W.R. suppression system. Basic data on the fluid dynamic forces encountered in this valve was obtained by hydraulic analogue technique.

Lucas are constantly extending the range of application of this technique into other fields and the Laboratory facilities are available for further work.

LUCAS

LUCAS GAS TURBINE EQUIPMENT LTD.,
BURNLEY, ENGLAND.
TELEPHONE ENQUIRIES, BURNLEY 25041

ATOM

MONTHLY INFORMATION BULLETIN
OF THE UNITED KINGDOM
ATOMIC ENERGY AUTHORITY

NUMBER 156

October 1969

Contents

ATOM
monthly bulletin of the UKAEA is distributed to the staff of the Authority, to similar organisations overseas, to industrial firms concerned with the exploitation of nuclear energy, to the Press and to others to whom a record of information of the work of the Authority may be useful.

Enquiries concerning the contents and circulation of the bulletin should be addressed to

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London EC1
Telephone 01-606 0577/8/9

U.K.A.E.A. PRESS RELEASE

Irradiated fuel from Japan

The *Leven Fisher*, a 2,355 ton (dead weight) vessel chartered by the U.K. Atomic Energy Authority from James Fisher & Sons Ltd. of Barrow, has arrived at Whitehaven on completion of a 30,000 mile round trip to Japan to transport irradiated fuel from the Tokai-mura reactor of the Japan Atomic Power Company.

The ship carries 20 tons of irradiated natural uranium fuel elements in 10 flasks each weighing 47 tons. For the next voyage, the number of flasks will be increased to 12. The flasks comply with the stringent safety requirements of the I.A.E.A. and have been approved by a number of safety authorities throughout the world. The ship has been specially equipped for the transport of irradiated fuel.

The ship sailed from Barrow early in May and loading in Japan at the port of Hitachi was completed in six days at the beginning of July. The ship sailed direct to Japan and back, calling only at Durban and Singapore for bunkering.

The flasks will be discharged from the ship at Whitehaven and taken by road to Windscale for the fuel to be unloaded. When the flasks have been unloaded and maintenance completed, they will be returned to the ship, which will sail for Japan about 9th September. The ship will sail continuously to and from Japan over the next three years.

This consignment of irradiated fuel is the first delivery under a contract between the Japan Atomic Power Company and the U.K.A.E.A. signed in April last year which provided for a total of 160 tons of irradiated fuel to be reprocessed by the U.K.A.E.A. The fuel will be reprocessed at Windscale to extract the valuable plutonium and the depleted uranium, which will both be returned to Japan.

Background notes

Tokai-mura power station

The Tokai-mura power station, 70 miles north-east of Tokyo, is a 154 MW (electrical) "Magnox" reactor supplied by the G.E.C./Simon Carves Atomic Energy Group. Nuclear heat is developed in natural uranium metal fuel elements,

The Leven Fisher, chartered by the United Kingdom Atomic Energy Authority from James Fisher and Sons Ltd. of Barrow, is seen at Whitehaven docks unloading a consignment of irradiated fuel from the Tokai-mura reactor in Japan.

each fuel element consisting of a metallic uranium fuel rod encased in a finned tube of the magnesium alloy " Magnox ". In this design of reactor, as in similar reactors in Britain, the heat is transferred from the fuel element to the boilers by high pressure, carbon dioxide gas.

Fuel for the Tokai-mura reactor is supplied by the U.K. Atomic Energy Authority and is manufactured at their Springfield Works, near Preston, Lancashire.

U.K.A.E.A. reprocessing facilities

The Authority's Windscale reprocessing plant has a capacity in excess of 2,000 metric tonnes of uranium per year. It reprocesses all the arisings of spent natural and enriched fuel from the British power reactors together with similar fuel from overseas reactors.

The Leven Fisher

The *Leven Fisher* is a motor vessel of 2,355 tons dead weight built in 1962 by Burntisland Shipbuilding Company Ltd. for James Fisher and Sons Ltd. and specially designed and strengthened for the carriage of large indivisible and heavy loads. The overall dimensions of the *Leven Fisher* are maxima for Queen's Dock, Whitehaven.

James Fisher and Sons, Ltd. have gained considerable experience in the sea transport of irradiated fuel with the *Stream Fisher* which pioneered the movement of irradiated fuel in quantity.

After extensive fitting out and trials, *Leven Fisher*, under the command of Captain J. Lundberg, sailed from Barrow for Japan on 2nd May, 1969, taking the Cape route calling at Durban and Singapore, and arriving at Hitachi on 1st July, 1969, ahead of schedule to find herself the first British ship to enter that port. Having loaded her cargo of irradiated fuel, *Leven Fisher* returned from Japan by the Cape route calling at Singapore and Durban. The next outward voyage is to be made via the Panama route. *2nd September, 1969*

The U.K. at Nuclex 69

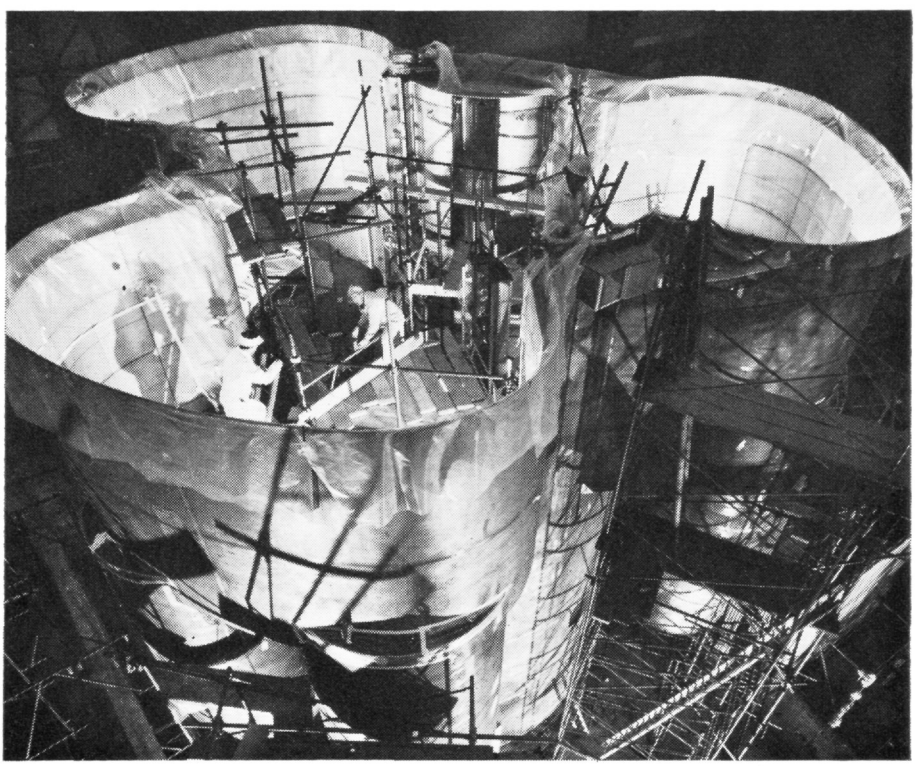
The British Nuclear Forum and the United Kingdom Atomic Energy Authority will present an integrated exhibit covering the whole range of British nuclear products and services at the "Nuclex" exhibition to be held in Basel from 6th-11th October. The U.K. stand will have an area of 1,000 square metres.

The U.K. has in operation over 4,100 MW of nuclear power with a further 6,380 MW under construction. The average load factor achieved by the U.K. operating stations is significantly higher than that of other reactors. This is a reflection of the long experience of the U.K. industry in designing and manufacturing equipment to the high standards of quality and reliability required for the nuclear industry.

The UKAEA will have a large display in the central area of the UK stand. The UK's extensive experience in the development of nuclear power—it has produced 60% of the world's nuclear electricity—will be briefly described and will be supported by technical exhibits describing Advanced Gas-cooled Reactors, High Temperature Reactors, Steam Generating Heavy Water Reactors, Fast Reactors, nuclear fuels, and nuclear equipment developed by the Authority and manufactured by industry.

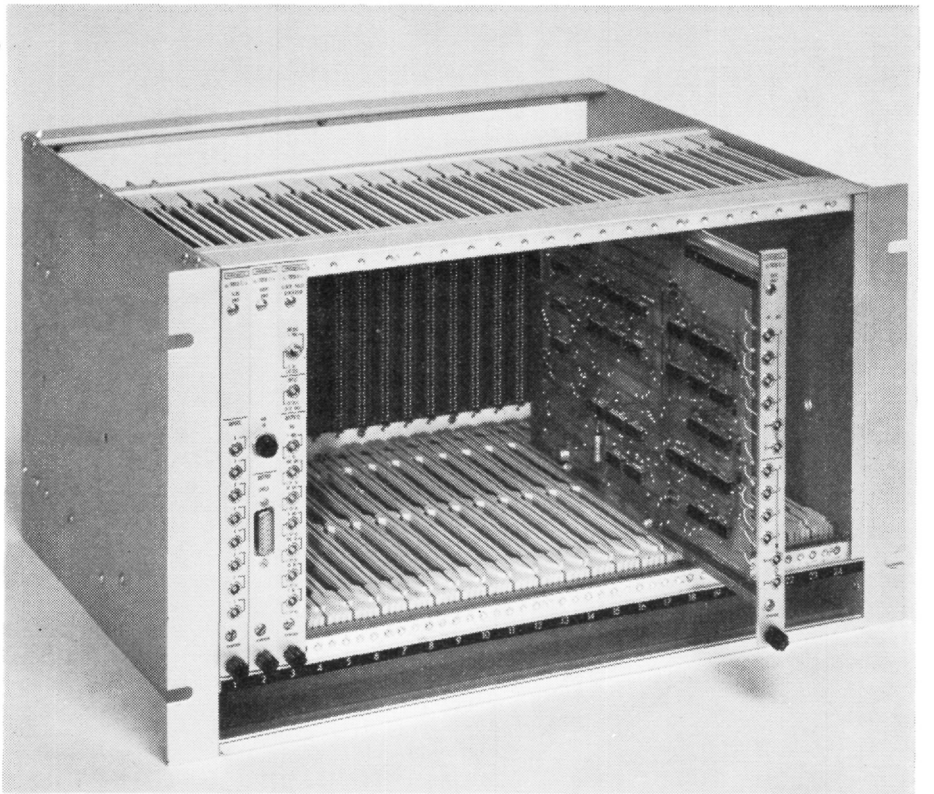
The Advanced Gas-cooled Reactor is the basis of the Second British nuclear power programme and a total of 4950 MW(e) of this type of reactor is under construction. The exhibit will cover the development of the AGR and include a description of the commercial AGR dynamic rig, used to test full-scale fuel stringers in the high velocity coolant conditions they will experience during on-load refuelling.

A model of a 450 MW(e) SGHWR will



The Prototype Fast Reactor which is under construction at Dounreay will produce 250 MW of electricity when it reaches full power. The picture shows the reactor jacket and intermediate heat exchanger pods viewed from above.

The first large-scale plant for the manufacture of plutonium enriched fuels has been built at Windscale. Initially it will make the fuel for the Dounreay Prototype Fast Reactor (P.F.R.) but will have additional capacity for reactor fuels. The plant is extensively automated and remotely controlled. The picture shows fully automated, logic controlled welding machine for end preparation of plutonium loaded P.F.R. fuel pins.



International agreement has been reached on a standard known as CAMAC for the design and manufacture of electronic instruments. Picture shows a CAMAC compatible crate with modules.

be exhibited and another display will emphasise a basic feature of this type of reactor—that various sizes of reactor can be designed using a standard channel tube assembly. The development of the reactor and the performance of the Winfrith SGHWR will also be described.

With the construction of the 250 MW (e) Prototype Fast Reactor at Dounreay well under way, the UK is established as a world leader in fast reactor technology, particularly sodium technology; a model of the PFR core will be exhibited and the use of a "mock-up" of a PFR core in the ZEBRA reactor to obtain reactor physics data and the development of PFR fuel described. There will be a display of sodium instrumentation developed by the Authority and a description of the Dounreay work on the sodium and water reaction in the NOAH rigs.

Fuel

The Production Group of the Authority will demonstrate its ability to provide highly competitive and efficient nuclear fuel reprocessing and manufacturing services to reactor operators overseas. The large-scale plants at Windscale and Springfields will be highlighted and particular emphasis will be placed on the new head end plant for reprocessing oxide fuels, the plutonium fuel fabrication plant, conversion of uranium ore concentrate to uranium hexafluoride and the Group's versatility in nuclear fuel manufacture. Currently the Group is reprocessing fuel from 30 power reactors and manufacturing fuel for 33 power reactors in the UK and overseas; both categories include reactors of foreign design.

The Radiochemical Centre, Amersham, will have displays describing neutron sources and Co-60 sources.

A.E.R.E. exhibits

The Atomic Energy Research Establishment, Harwell, will have displays describing radiation and post-irradiation facilities, remote handling equipment, health physics instrumentation, isotope

Saddle-coil flowmeter—an electromagnetic flowmeter for measuring sodium flow in large diameter pipes.

powered generators, a proton scattering microscope, gamma sterilisation plants, geological survey equipment, an automatic potentiometric titrator employing Harwell 2000 series modular electronic equipment, a neutron chopper system, and a range of nuclear and data processing instruments fully compatible with the CAMAC specification. Descriptions of the Authority's irradiation services at Harwell and Dounreay will have a prominent position on the stand.

Aldermaston work

Exhibits from the Atomic Weapons Research Establishment, Aldermaston, will cover radiation measuring instruments, accelerators for heavy ion bombardment, and a gel precipitation technique for the preparation of oxides of controlled shape, size and composition.

Also on the UKAEA stand will be a technical library with scientific and commercial publications.

Design industries contribution

British Nuclear Design & Construction Ltd. will demonstrate their experience and expertise on nuclear power generation with models of Hinkley Point "A", Sizewell, Wylfa, Dungeness "B" and Hartlepool. Also on view will be models of the Steam Generating Heavy Water Reactor; of the fuel arrangements for a High Temperature Reactor; of pre-

stressed concrete pressure vessels and of the newly developed pod-boilers for the B.N.D.C. design of a gas-cooled reactor.

The Nuclear Power Group's stand will provide details of their activities in the design and construction of nuclear power stations, together with their shareholding companies. Models and drawings on display will cover: Bradwell, Berkeley, Latina, Dungeness "A", Hunterston "B", Dounreay P.F.R., the High Temperature Reactor and the Steam Generating Heavy Water Reactor. Exhibits from shareholding companies will include details of pre-stressed concrete pressure vessels and liners, welding equipment, charge/discharge machinery, graphite and reactor equipment.

Fairey Engineering Ltd. will emphasise their role in the research reactor field with models of HERALD and HELEN; recent contracts worth over £4 million for research reactors and training facilities have been obtained in Switzerland, Romania, Chile and Brazil. The company's activity in the design and construction of reactor cores will also be demonstrated.

Products illustrated on the stand of English Electric Reactor Equipment Division will include reactor core components, structures and measuring equipment; on-load and off-load fuel-handling equipment; mechanical and electromagnetic sodium pumps and a wide range of instrumentation. Associated with this exhibit will be: Elliott Process Instruments Ltd., neutron flux instruments, safety systems and control mechanisms; Elliott-Automation Radar Systems Ltd., neutron generators and activation analysis equipment; English Electric—A.E.I. Projects Ltd., computer applications in nuclear power generation.

The Babcock & Wilcox stand will include a model of the 570-ton B.W.R. pressure vessel for Ringhals I in Sweden and will demonstrate their expertise in all types of reactor systems.

Other British exhibitors will be: Avica Equipment Ltd., specialised components for piping and ducting; Bristol Aerojet Ltd., experimental equipment, power reactor components, mineral insulated cable; Extended Surface Tube Co., finned tube for nuclear power station boilers; Fine Tubes Ltd., advanced gas reactor and fast breeder cans; Flight Refuelling Ltd., standpipe closures and non-return valves; Graviner Manufacturing Co. Ltd., shielded cells built from 100-250 m.m. thick interlocking bricks; Imperial Metal Industries Ltd., reactor and sub-reactor components in special metals; Plessey Co. Ltd. burst fuel-element detection equipment and health monitors; Rio Tinto Zinc Corporation Ltd., mining exploration and development; Spembly Technical Products Ltd., protection systems, temperature measurement, cryogenics and furnaces; System Computors Ltd., control and instrumentation systems for nuclear plant; T.I. (Export) Ltd., fuel element cans, reactor components and pipework; 20th Century Electronics Ltd., nuclear radiation detectors, photomultipliers and cathode ray tubes; Vickers Ltd., reactor materials testing rigs and loops, particle accelerators; "Nuclear Engineering International", magazine circulating to 84 countries.

I.R.P.A. Congress

The Second International Congress of the International Radiation Protection Association will be held at Brighton, Sussex, from 3rd to 8th May, 1970. The Congress is being organised by a committee of the British Radiological Protection Association.

An exhibition, held concurrently with the Congress, will cover all aspects of radiation protection, such as instrumentation, handling equipment, shielding, transport, protective clothing and breathing apparatus, and will include established equipment together with new ideas or equipment still under development.

Abstracts of papers must reach the Secretary of the Scientific Programme Committee (Mr. H. J. Dunster, Harwell, Didcot, Berks., England) by 1st November, 1969; complete papers by 1st April, 1970.

Film Catalogue

A new edition of the United Kingdom Atomic Energy Authority's film catalogue has now been published. It lists over 60 films, dealing with many aspects of nuclear energy, which are available on free loan from the Authority. Copies of the catalogue are available from Public Relations Branch, U.K.A.E.A., 11, Charles II Street, London, S.W.1.

A.E.R.E. Post-Graduate Education Centre

THE following courses are due to be held at the Post-Graduate Education Centre, A.E.R.E., Harwell, Didcot, Berks. Further information and enrolment forms can be obtained on application. The fees shown are exclusive of accommodation.

Glassblowing

10th November to 5th December, 1969
12th January to 6th February, 1970
9th February to 6th March, 1970
6th April to 1st May, 1970
27th April to 22nd May, 1970
1st to 26th June, 1970
29th June to 24th July, 1970
27th July to 21st August, 1970

A practical course covering the rudiments of scientific glassblowing and other techniques used in working with glass.

There are at least two hours of instruction each day followed by practice, all under the immediate supervision of an experienced glassblower. The number on each course is small so that individual attention can be given and the level of instruction varied to suit the aptitude of the individual. Beginners are accepted but those with some experience can start immediately on more advanced work. A certificate of attendance is given and a confidential assessment of performance and aptitude is made. Fee: £120.

Radiological Protection

8th to 12th December, 1969
16th to 20th March, 1970
8th to 12th June, 1970
9th to 13th November, 1970

Lectures, demonstrations and practical work designed to give some experience in the safe handling of radioisotopes. While it is assumed that students are normally graduates in science or engineering, or hold equivalent qualifications, such qualifications are not considered essential to attendance. This course is intended to be of use to "competent persons" since it contains information about safety precautions when using x-rays, industrial use of radioisotopes, instrumentation and the regulations applicable to the use of ionising radiations.

The practical work is to familiarise students with simple measurements and calculations associated with radiological protection. Fee: £40.

Two-Phase Heat Transfer

5th to 9th January, 1970
1st to 5th June, 1970

Should be of particular value to engineers and scientists working in the field but may also appeal to those requiring an introduction to two-phase heat transfer.

The subject is approached in a fundamental way and although its application to nuclear reactors problems has some emphasis, the material presented is useful to those requiring a knowledge of the problems inherent in two-phase heat transfer and of current solutions, theories and developments. The lectures are given by experts in their subjects and ample time is allowed for discussion.

The course in January is held at A.E.E. Winfrith and in June at Harwell.

There are visits to laboratories at Winfrith or Harwell. Fee: £40.

Modern Physical Techniques in Materials Technology

12th to 16th January, 1970
19th to 23rd October, 1970

Arranged in conjunction with the Institute of Physics and the Physical Society and the Metals and Metallurgy Trust.

Presents an opportunity to scientists engaged in research and development to familiarise themselves with seventeen different modern physical techniques of vital importance in materials technology. Lectures are given by specialists actively engaged in these fields.

The basic principles of each technique are outlined, together with the scope and limitations, and the course presents an overall picture of the inter-relation of the techniques and of their applications in the physical sciences. Fee: £40.

Radioisotope Methods in Chemistry

26th January to 13th February, 1970

Intended for chemists employed in pure or applied research who need a basic introduction to radioisotope methods coupled with specialised information in particular chemical fields.

Students will be encouraged to suggest experiments which they wish to carry out in the third week. Fee: £120.

Advanced Radiological Protection

16th February to 13th March, 1970

For the experienced health physicist to extend his understanding of the underlying philosophy and scientific bases of his profession. Attention is also given to the managerial and professional responsibilities of the health physicist. The subjects covered include many of those dealt with in the Post-Graduate Radiological Protection Course but emphasise more advanced aspects and modern developments.

The topics include more advanced lectures on radiation physics, dosimetry and modern developments in radiation detection. The practical work comprises syndicate studies in place of laboratory work, to provide participants with an opportunity to conduct joint exercises with their professional colleagues from other establishments and countries and so obtain a very wide perspective of their profession. Fee: £160.

Seminar on Harwell's Multi-access Computing System

18th and 19th February, 1970
13th and 14th May, 1970

The objective is to describe and discuss the multi-access computing facilities developed at Harwell for use on the IBM system/360 computer. The system is designed to operate efficiently with conventional batch-processing. Participants are given the opportunity to use it. Lectures describe how it is implemented, giving particular emphasis on what is required for similar systems to be implemented on other computers. Fee: £16.

Pressurised Equipment

9th to 13th March, 1970

For designers of graduate level who are concerned with pressurised equipment in a research and development environment.

Covers the following broad aspects of the subject:

Design of vessels, seals, joints, flanges; other practical aspects of design; materials and the effects of special environments; recent work on fracture mechanics and high pressure engineering.

Lectures are given by specialists from Harwell and Risley, from Government and industrial research and design establishments and from a University. Fee: £40.

U.K.A.E.A. SCIENTIFIC AND TECHNICAL NEWS SERVICE

Neutron radiographic service at Harwell

The Nondestructive Testing Centre, in conjunction with the Research Reactors Division, A.E.R.E., Harwell, is now offering a neutron radiography service.

Neutron radiography is similar in many ways to X-radiography and can be regarded as a complementary quality control technique. A beam of neutrons is used to produce an image of the internal details of an object and the final picture is obtained on photographic film. The detection process, however, is slightly different; whereas X-rays interact directly with the photographic material to produce the familiar X-radiograph, neutrons interact with a thin sheet of detector material to produce nuclear reactions and the radiation emitted following these reactions is used to expose an X-ray film placed in contact with the detector.

The usefulness of neutron radiography lies in the differences in the nature of the absorption process from that for X-rays. The rate of absorption of X-rays increases steadily from element to element with increasing atomic number, but for neutrons the rate of removal from a beam (by scattering as well as absorption) varies in a random manner from one element to the next. As an example, hydrogen and hydrogenous materials can be readily radiographed by neutrons in circumstances where X-rays can be ruled out. This was clearly demonstrated at Harwell as long ago as 1956 when a piece of waxed string was radiographed through a four inch lead block. Because of the hydrogen content, materials such as explosives can be detected in heavy casings, water in thick steel pipes, thin rubber and plastic parts in heavy assemblies and films of resin adhesives in metallic aerospace components. Amongst many elements easily detected by neutron radiography are the "lighter" elements lithium, beryllium and boron, and the rare earth elements gadolinium, europium and dysprosium.

Beams of neutrons suitable for neutron radiography are available from the Harwell reactors DIDO and LIDO and an

antimony-beryllium isotopic neutron source is being installed.

Neutron radiography was featured on the Nondestructive Testing Centre's stand at the "NDT 69" exhibition of the Nondestructive Testing Society of Great Britain, held at the University of Reading, 2nd-5th September.

Further information about the neutron radiographic service is also available from the NDT Centre, A.E.R.E., Harwell, Didcot, Berks. *26th August, 1969*

MQ20 pressure transducer

A piezo-electric quartz pressure sensing device, the MQ20 pressure transducer, has been developed at A.W.R.E., Foulness.

The Meclec Company, Star Lane, Great Wakering, Essex, (Telephone No. Great Wakering, 722), and Coutant Transducers, 47, Milford Road, Reading, Berks. RG1 8LN. (Telephone No. Reading 40166), have been licensed to manufacture the MQ20, and transducers certified as to quality and calibration by A.W.R.E., Foulness, can be obtained from them. Meclec also make a wide band high input impedance amplifier specially designed for use with MQ20 pressure transducers and similar piezo electric devices.

The MQ20 was originally developed for blast pressure measurement in armaments research and rocket restarch.

In a piezo-electric device, mechanical strains (induced e.g. by blast or shock) produce opposite polarity electric charges on different faces of a crystal; the charges are amplified and recorded.

The MQ20 is one of a range of piezo-electric quartz pressure sensing devices developed at Foulness for the measurement of dynamic pressures. Experience has shown that, with quartz, the performance is stable over long periods, and that for dynamic measurements this type of transducer is, at present, a long way ahead of transducers built with other sensing devices. Used with wide band, high input impedance amplifiers, the MQ20 has given consistently clear and true dynamic pressure records.

5th September, 1969

Nominal characteristics

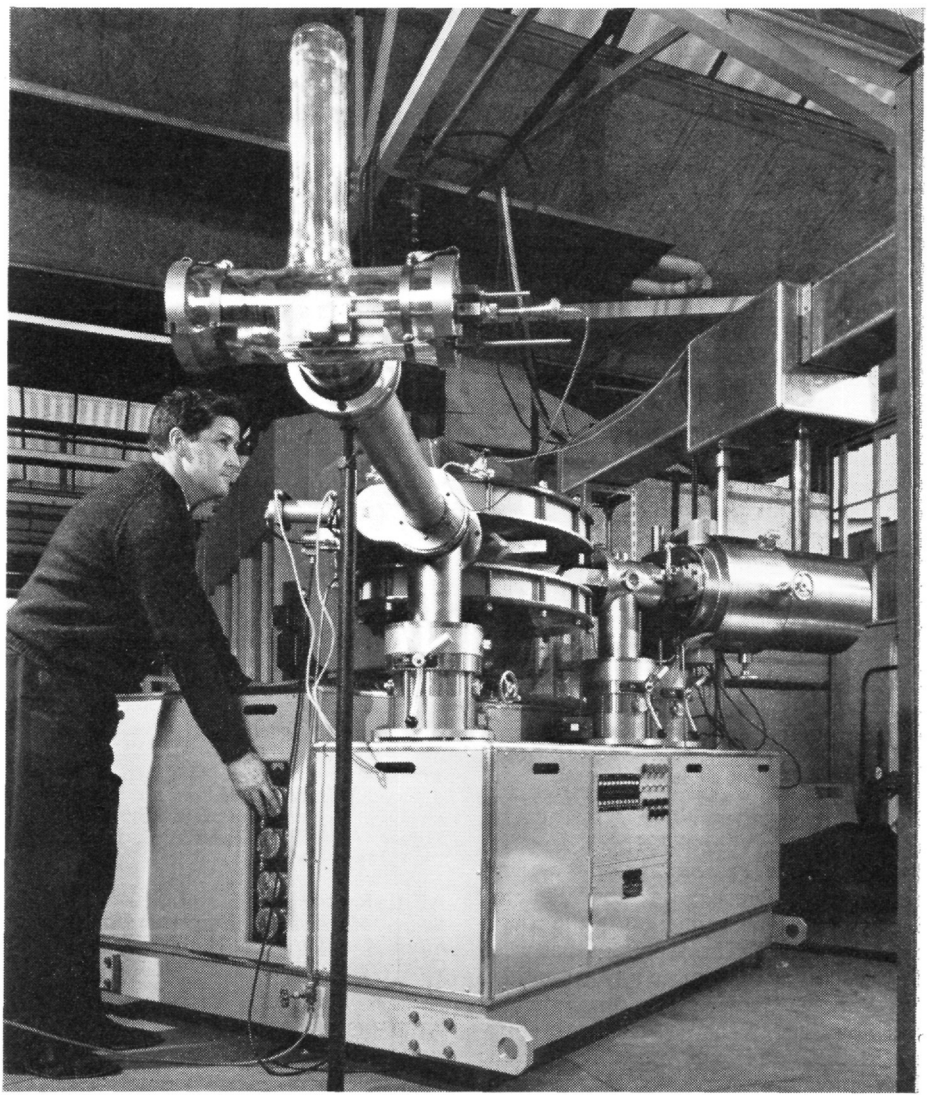
Dynamic		
Dynamic pressure range	0-30,000 psi	0-2100 kg/cm^2
Charge sensitivity	0.5 pC/psi	7×10^{-12} C/kg/cm^2
Voltage sensitivity with 6ft. cable	2.6 mV/psi	37 mV/kg/cm^2
Capacity with 6ft. cable	190 pF	
Resonant frequency	275 kc/s	275 kHz
Rise-time (face-on)	1.5 microseconds	
Resolution	Infinite	
Acceleration sensitivity	<0.01 psi/g	
Physical		
Size	7/16" dia × 7/8" (11 mm dia × 21 mm).	
Weight	0.28 oz (8 g)	
Measuring system	Piezo-electric	
Measuring element	Quartz crystal	
Mechanical preload	Vacuum assembled and sealed	
Body material	Stainless steel	
Diaphragm material	Stainless steel	
Electrical connector	Coaxial No. 10 UNF thread. Mates with cable.	
Connecting cable	Low-noise sub-miniature cable	
Cable capacity	180 pF for 6ft. complete with connectors.	
Accessories included	(i) 6ft. (183 cm) sub-miniature coaxial cable terminated each end with No. 10 UNF sub-miniature connectors. (ii) Adaptor to system connector.	
General		
Calibration	Semi-dynamic	
Insulation	$>10^{12}$ Ohm	

New isotope separator

Lintott Engineering Ltd., has been licensed by the U.K. Atomic Energy Authority to produce and market a new isotope separator and heavy ion accelerator designed at A.E.R.E., Harwell. It is intended as a low cost, compact laboratory facility for the separation of high purity isotopes as well as for a wide range of ion interaction studies. The novel focusing arrangements permit considerable experimental flexibility with a resolution and dispersion comparable with much larger conventional separators. The high beam intensity of the machine is adequate for production scale semiconductor doping.

The Department of Electrical Engineering, Salford University, have placed an order for a variable energy separator of this type to be installed by A.E.R.E., Harwell and Lintott Engineering Ltd. this month. A second machine is on order for the National Bureau of Standards, U.S.A., for delivery by 31st March, 1970.

The separator, which uses the standard Harwell ion source with a 4 cm extrac-



The Harwell isotope separator and heavy ion accelerator which will be installed at Salford University by the Atomic Energy Research Establishment, Harwell and Lintott Engineering Ltd.

tion slit, has a 60°, 40 cm, radius homogeneous field deflecting magnet. The magnet is fitted with wide pole tips with rotatable inserts and its effective deflecting radius can be adjusted by movement towards, or away from the centre of curvature. The combination of these adjustments permit considerable variations in the geometry of the analyser and allow the focal length, the dispersion and the divergence of the ion beam to be controlled over wide limits.

The machine is well suited for both stable and radioactive isotope separations. Milliampere beam intensities, corresponding to a mass transport of milligrams per hour can be obtained for most elements.

Isotope separators have been used as heavy ion accelerators for a wide variety of ion beam studies in sputtering, "hot atom" chemistry, ion-molecule formation and atomic physics. The widest interest at present is for ion implantation where the wide range of ions and the high beam intensities which can be routinely obtained are very valuable.

For many experimental applications the high resolution and dispersion of the Harwell separator are not essential. They do, however, assist greatly in the ease of operation since the sharply-resolved isotope spectrum permits the rapid identification of the required ion beam.

The milliampere beam intensity (6×10^{15}ions/sec) of the separator is adequate for the large-scale ion doping of semiconductor devices.

Enquiries concerning the Harwell isotope separator should be addressed to: Mr. D. R. Willis, Lintott Engineering Ltd., Foundry Lane, Horsham, Sussex. Tel: Horsham 3316.

Further details of the Harwell Ion Source are given in Nuclear Instruments and Methods, Volume 22, 1963, pages 306-316 and in Proceedings of the International Conference on Ion Sources, Saclay, June 1969, at present in the course of preparation. The separator has been described in more detail in a paper entitled "A Variable Geometry Isotope Separator and Low Energy Heavy Ion Accelerator" by Mr. H. Freeman, presented to the International Conference on Mass Spectrometry at Kyoto, Japan, September 1969.

8th September, 1969

A.E.A. Reports available

THE titles below are a selection from the September 1969, "U.K.A.E.A. list of publications available to the public". This list is obtainable free from the Librarian, A.E.R.E., Harwell, Didcot, Berkshire. It includes titles of all reports on sale, translations into English, books, periodical articles, patent specifications and reports which have appeared in the published literature. It also lists the Depository Libraries in the U.K. and the countries with official atomic energy projects which receive copies of U.K.A.E.A. unclassified reports.

AERE-M 2157 (Revised)
Average Fission Cross Sections and Resonance Integral Contributions between 10 eV and 20 keV Deduced from SCISRS Data Tapes. By G. D. James and M. G. Schomberg. June, 1969. 6pp. HMSO 2s. 6d.

AERE-M 2216
Burnout Heat Flux Measurements in a Long Tube. By F. R. Dell, G. F. Hewitt, R. K. F. Keeys and R. A. Stinchcombe. June, 1969. 7pp. HMSO 2s. 6d.

AERE-R 5374
Liquid Entrainment in Adiabatic Steam-Water Flow. By G. F. Hewitt and D. J. Pulling. June, 1969. 11pp. HMSO 2s. 6d.

AERE-R 6063
The Half-life of ^{198}Au and the Measurement of Half-Lives by Gamma-Ray Spectrometry. By M. J. Cabell and M. Wilkins. June, 1969. 46pp. HMSO 7s.

AERE-R 6070
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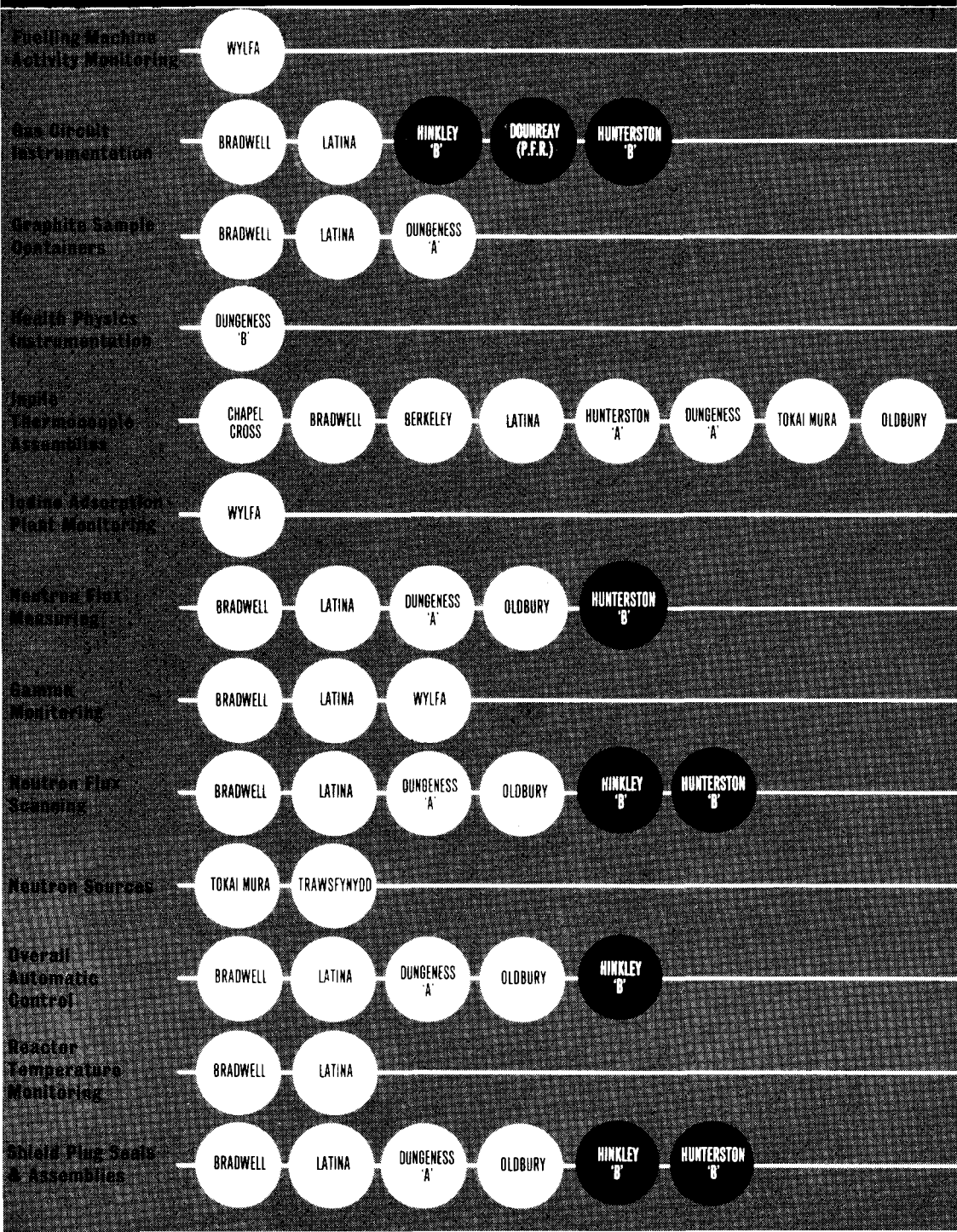

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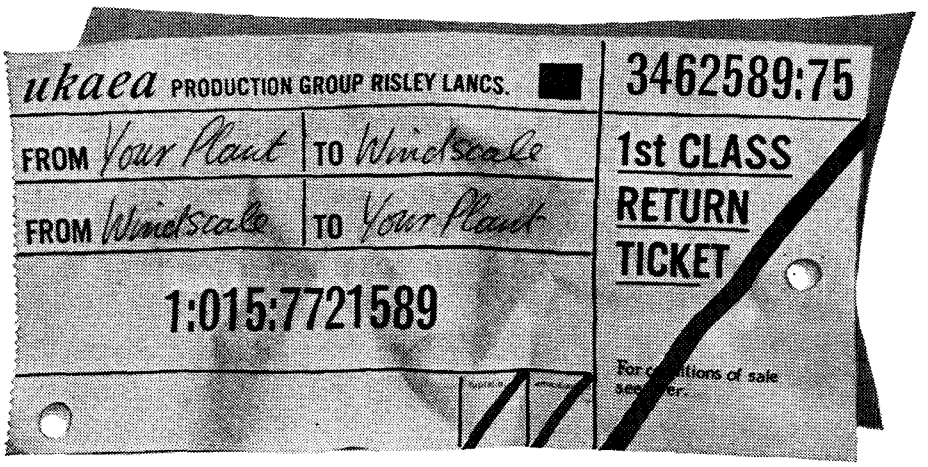

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