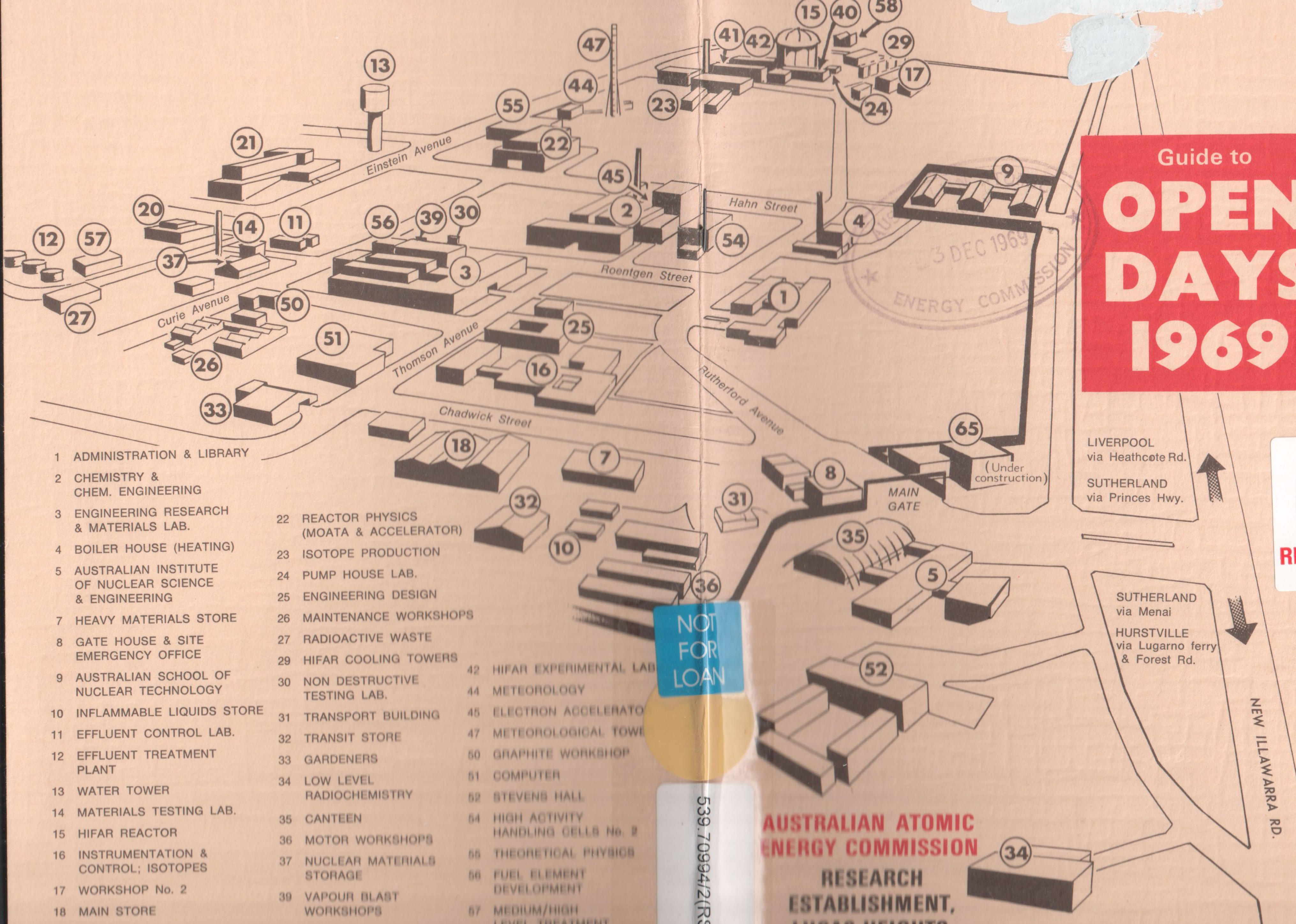
Guide to OPEN DAYS 1969



1 ADMINISTRATION & LIBRARY
2 CHEMISTRY & CHEM. ENGINEERING
3 ENGINEERING RESEARCH & MATERIALS LAB.
4 BOILER HOUSE (HEATING)
5 AUSTRALIAN INSTITUTE OF NUCLEAR SCIENCE & ENGINEERING
7 HEAVY MATERIALS STORE
8 GATE HOUSE & SITE EMERGENCY OFFICE
9 AUSTRALIAN SCHOOL OF NUCLEAR TECHNOLOGY
10 INFLAMMABLE LIQUIDS STORE
11 EFFLUENT CONTROL LAB.
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16 INSTRUMENTATION & CONTROL; ISOTOPES
17 WORKSHOP No. 2
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AUSTRALIAN ATOMIC ENERGY COMMISSION

RESEARCH ESTABLISHMENT, LUCAS HEIGHTS

OPEN DAYS LUCAS HEIGHTS 1969

WEDNESDAY, 10 SEPTEMBER
9.30 a.m. — 4.30 p.m.

THURSDAY, 11 SEPTEMBER
9.30 a.m. — 4.30 p.m.

FRIDAY, 12 SEPTEMBER
12 noon — 4.45 p.m.

Lucas Heights, the site of the Australian Atomic Energy Commission's Research Establishment, is about 20 miles south of Sydney. It can be reached by road from Sutherland or Liverpool. Please refer to the map on your admission ticket.

There is no organised transport service to Lucas Heights but vehicle parking areas have been provided.

Visitors are requested to complete and detach the name slip from the admission ticket and hand it to the receptionist on arrival.

CAMERAS MAY NOT BE TAKEN ONTO THE SITE

PLEASE BRING THIS GUIDE BOOK WITH YOU

FOREWORD

The Chairman, Commissioners and Staff of the Atomic Energy Commission welcome you to this Open Day at the Research Establishment.

We have made special arrangements to open many areas not usually available for inspection and have arranged exhibits to show the great variety of research and production activities in which the Commission is engaged. The staff will answer your enquiries and try to make your visit both instructive and enjoyable.

The most tangible benefit to Australia to date from the work at Lucas Heights is the production of radioisotopes for medical diagnosis and treatment, for application in industrial production techniques, for research in our own and other laboratories throughout the country, and for export to nearby countries.

But it must be emphasised that this is only a part of our work. We have here a team of experts skilled in all aspects of nuclear science and engineering and ready to play their part in establishing a nuclear power industry in Australia. The buildings, plant, special facilities unique in Australia, and the novel pieces of equipment on display make up a significant investment in an advanced technology. In our research program we are preparing for the role of the atom in assisting our national development.

In the time available you will not be able to see all the displays. We hope you will use this booklet to select those displays of special interest to you, together with others which will extend your knowledge of the Commission's work.

K. F. ALDER,

Director, Research Establishment.

CONTENTS

The position of each exhibit is indicated by a building and room number. The locations of the buildings open for inspection are shown on the diagram on the cover of this booklet. Within each building, notices and signs will direct you to the exhibits.

GENERAL INFORMATION

Area of Site	340 acres
Construction Started	October, 1955
Capital Cost	$30,000,000
Staff	Approximately 1,100
Correspondence Address	The Director, AAEC Research Establishment, Lucas Heights, Private Mail Bag, Sutherland, N.S.W. 2232
Telegraphic Address	ATOMCOM, SYDNEY
Telephone	531-0111

SPECIAL ARRANGEMENTS

Enquiries — Call at enquiry desks in the foyers of Buildings 1, 2, 3 and 16.

Bus and Car Parking — Vehicle parks are available near the Main Gate.

Local Bus Service — Cars and buses may not enter the Main Gate. Visitors may use a free Commission bus service on a circuit within the Research Establishment.

Refreshments — Light refreshments are available all day in the Canteen (Building 35, opposite the Main Gate).

Lunch — The Canteen, as far as possible, will provide a Cafeteria service from 12 noon to 2 p.m.

Toilets — Toilets are in Buildings 1, 2, 3, 5, 16, 21, 22, 40, 55, 58 and the Canteen.

First Aid — Dial the emergency number 5 on any telephone on the site.

Prohibited Areas — Visitors must carefully observe notices displayed throughout the site which may prohibit entry in the interests of maintaining production or preserving the safety of visitors and staff. The electricity sub-stations and any buildings under construction are not open for inspection.

Inspection of HIFAR — The large reactor HIFAR will be open for inspection by parties strictly limited in size. You may join the conducted tours by entering at the south end of Building 41, near the white, sealed building. Entry will be strictly controlled; excessive demand may necessitate cancellation of the arrangement.

Cameras, Suitcases, Briefcases, etc. — Please note that cameras, suitcases, briefcases, etc., may not be brought onto the site. Cloakroom facilities will be provided at the Main Gate.

Film Showings AINSE Theatre, Building 5 (Outside Main Gate)
Daily, 10.00 a.m. to 4.30 p.m.

Film		Times of Screening
Search for Uranium (28 mins.)	a.m.	10.00, 11.30
	p.m.	1.00, 2.30, 4.00
Atoms for Everyday (18 mins.)	a.m.	10.30, 12.00
	p.m.	1.30, 3.00
Plowshare (28 mins.)	a.m.	10.55
	p.m.	12.25, 1.55, 3.25

Building 55 Theatre
Wednesday, 10th September, 10.00 a.m. to 4.30 p.m.

Film		Times of Screening
Criticality (20 mins.)	a.m.	10.00, 10.55, 11.50
	p.m.	12.45, 1.40, 2.35, 3.30
Conquest of the Atom (22 mins.)	a.m.	10.25, 11.20
	p.m.	12.15, 1.10, 2.05, 3.00, 3.55

Thursday, 11th September, 10.00 a.m. to 4.30 p.m.

Film		Times of Screening
Criticality (20 mins.)	a.m.	10.00, 10.55, 11.50
	p.m.	12.45, 1.40, 2.35, 3.30
Lucas Heights (25 mins.)	a.m.	10.25, 11.20
	p.m.	12.15, 1.10, 2.05, 3.00, 3.55

Brief Descriptions of Films

ATOMS FOR EVERYDAY

This film, produced by the AAEC, surveys the use in Australia of radioisotopes for industrial, agricultural, scientific and medical purposes. Also shown is the Commission's HIFAR nuclear reactor which is used for the production of radioisotopes.

CONQUEST OF THE ATOM

Recounts man's discovery and exploration of the atom. The film uses both live photography and animation, and was made primarily for secondary schools.

CRITICALITY

Describes conditions under which a chain reaction can occur in fissile material. The basic principle of nuclear fission is also explained with the aid of animation.

LUCAS HEIGHTS

This film produced by the AAEC covers much of the work carried out at the Research Establishment and shows the specialised equipment and laboratories in use. Several fields of study are covered, including engineering, nuclear physics, chemistry, metallurgy, meteorology and radiation biology.

PLOWSHARE

Plowshare is the name given to the United States Atomic Energy Commission's program on the peaceful uses of nuclear explosions. This film introduces that program and presents the status and development of the safe use of nuclear explosions for civilian applications.

SEARCH FOR URANIUM

Made by the AAEC to show the development of a national program of uranium exploration and prospecting and the techniques employed, from broad national surveys to the stage of diamond drilling and collection and analysis of samples.

ISOTOPE DIVISION

INTRODUCTION

The Isotope Division undertakes research and development of industrial, medical and scientific applications for radioisotopes and radiation and is responsible for radioisotope production using the AAEC's research reactor HIFAR. The Division encourages and assists Australian industry and science in the use of radioisotopes wherever positive advantages can safely be obtained from their use. The Division has three sections:

Isotope Applications Research

As well as providing an advisory service in the use of radioisotopes, this section develops new radioisotope applications in industry, agriculture and scientific research. Important techniques recently developed include methods for the analysis of minerals using low energy X-ray and gamma-ray sources, the measurement of flow in gas pipe-lines and methods for determining tritium (a radioisotope of hydrogen) in natural waters.

Radioisotope Production

This section is responsible for the production of radioisotopes using HIFAR, the manufacture of radioisotope sources, and the dispensing, packaging and despatch of radioactive solutions for use in medicine, industry and research. New techniques are developed for producing radioisotopes and labelled compounds. Particular attention is given to developing radiopharmaceuticals labelled with short half life radioisotopes such as technetium 99m and fluorine 18 which are important in medical diagnoses.

Irradiation Research

This section studies the effects of radiation on materials and processes. Useful radiation applications being investigated include the sterilization of medical supplies, the synthesis of chemicals, the manufacture of plastics and the preservation of food. The section's extensive gamma irradiation facilities and electron accelerator are made available for use by external organisations.

For Isotope exhibits visit Buildings 16, 23, 45. To see all aspects of Radioisotope Production and Irradiation Research follow the arrows in Building 23.

ISOTOPE APPLICATIONS RESEARCH

16 T18 T25 **MEASUREMENT OF GAS FLOW RATE**

Radioisotope techniques have been used to measure flow in town gas reticulation sytems and in industrial plants.

RADIOISOTOPES IN HYDROLOGICAL STUDIES

Equipment for the low level counting of the hydrogen isotope tritium in natural waters is on display. The information obtained will assist in estimating the age of underground water supplies. Techniques for measurement of river flow rate are also displayed.

T67 and T68 **ON-STREAM ANALYSIS OF MINERAL SLURRIES**

Radioisotope X-ray sources developed at Lucas Heights are used in mineral processing plants to measure the concentrations of minerals in slurries.

RADIOISOTOPE X-RAY TECHNIQUES FOR THE ANALYSIS OF MATERIALS

A model demonstrates measurement of the thickness of thin coatings of tin on steel (tinplate).

RADIOISOTOPE PRODUCTION SECTION

(Follow the arrows)

23 **ISOTOPE HANDLING BAY**

A battery of 16 cells, shielded with 4 inches of lead, is used to handle, load and measure sealed radiation sources, dispense radioactive gases, and perform the preliminary handling of radioactive materials from the reactor HIFAR before passing them to the radiochemical processing building.

23B Foyer **GENERAL EXHIBITION**

Shows how isotopes are manufactured and gives a guide to facilities open for inspection.

23B 18

RADIOISOTOPE PRODUCTION PLANNING OFFICE

In this room orders for radioisotopes are received and processed. Reactor irradiation programs and all deliveries are planned. The planning schedule boards are on display.

23B 26

TARGET PREPARATION

This small exhibit shows the method of purifying materials to be irradiated. The ways in which materials are canned for reactor irradiations are illustrated.

23B 24

GAMMA-RAY SPECTROMETER

Used for identification of radioisotopes by detecting the characteristic gamma-rays they emit.

DIRECT READING ION CHAMBER

This instrument gives a direct reading of the activity of isotopes bottled and ready for shipment.

DENSITOMETER

Measures radiation intensity using film.

SHIELDED ION CHAMBER ASSEMBLY

This is used to measure radioactivity without interference from natural background radioactivity.

23A

CORRIDOR LEADING TO COBALT CELL

Photographs, etc., are shown of processes carried out in the nearby radiochemical processing facility. This facility cannot be inspected as it is in continuous operation, producing short-lived radioisotopes for medical diagnosis and treatment.

23

CORRIDOR LEADING TO DESPATCH CENTRE AND ISOTOPE HANDLING BAY

A view may be obtained through an observation window of a radiochemical processing facility designed for experimental work. This facility has radiation shielding of lead. Processes for preparing radiochemicals are developed here.

23

DESPATCH CENTRE

Typical packaging systems for radioactive materials to be transported by land, sea and air are shown. Safe transport of these materials is provided for in State, Commonwealth and international safety regulations.

23

COBALT 60 CELL

This cell is used for manipulating very highly radioactive materials by remote handling and visualisation techniques. In particular, cobalt 60 sources for cancer treatment are measured and assembled. The cell also includes a gamma irradiator containing 10,000 curies of cobalt 60. Large transport containers for high activity radioactive sources are on display. These containers comply with international safety regulations.

IRRADIATION RESEARCH SECTION

23 South end of Main Bay

GAMMA IRRADIATION POND USING SPENT FUEL ELEMENTS

When fuel is removed from HIFAR it can still be used as an intense source of gamma radiation. The pond also has experimental irradiators using 100,000 curies of cobalt 60.

DISPLAY CABINETS

Effects of radiation on samples of various materials.

23C 10

STUDIES OF BIOLOGICAL EFFECTS OF GAMMA RADIATION

Displays include preservation of food and sterilization of pharmaceuticals.

12

THE EFFECT OF RADIATION ON ORGANIC CHEMICALS

Thin layer chromatography apparatus is on display.

15

RADIATION CHEMISTRY INVESTIGATIONS OF AQUEOUS CHEMICAL SYSTEMS

Equipment to study reactions of the hydrated electron and the hydroxyl radical is on display, together with samples of wood impregnated with plastic and cured by ionising radiation.

23C 14 **F AND M GAS CHROMATOGRAPHY UNIT**
NESTER-FAUST PREPARATIVE GAS CHROMATOGRAPHY UNIT
THIN LAYER CHROMATOGRAPHY APPARATUS

Used for the isolation and identification of degradation products in irradiated organic materials.

13 **GAMMA IRRADIATORS USING 1,500 CURIES OF COBALT 60**

The gamma irradiators displayed are designed for laboratory use and are integrated with apparatus for studying the radiation sensitivity of micro-organisms at temperatures up to 100°C and pressures up to 3,000 atmospheres.

EQUIPMENT FOR THE STUDY OF ELECTRODE PROCESSES UNDER IRRADIATION

This concerns metal corrosion in research and power reactors.

8 **LIQUID SCINTILLATION COUNTING EQUIPMENT**

ULTRAVIOLET AND INFRARED SPECTROPHOTOMETERS

SPECTROFLUORIMETER

45 **1.3 MILLION VOLT VAN DE GRAAFF ELECTRON ACCELERATOR**

Used for radiation chemistry research.

PULSE RADIOLYSIS EQUIPMENT

Used with the accelerator to investigate chemical reactions of durations as short as one millionth of a second.

CURING OF THIN COATINGS

Prepared by electron beam irradiation.

PLASTIC IMPREGNATED CONCRETE

APPARATUS FOR STUDYING THE RADIOLYSIS OF GASEOUS SYSTEMS

Includes high vacuum apparatus with automatic Toepler pumps and an all-glass circulating pump, and gas and thin layer chromatography equipment.

INSTRUMENTATION AND CONTROL DIVISION

INTRODUCTION

Instrumentation and measurement facilities at Lucas Heights are the special responsibilities of this Division. It provides the following services to other Divisions:

(a) Electronic design.
(b) Application of small digital computers to experiments.
(c) Maintenance and calibration of instruments.
(d) Measurement and control of process variables such as temperature, pressure and flow rate in large-scale engineering experiments.

A PACE 231R analogue computer is used to study stability and control of various power reactor systems.

The Division also does research on the application of various modern nuclear radiation detectors, especially semiconductor devices using lithium drift techniques in both germanium and silicon. The Division has established an international reputation in this field. In addition, it has a program to establish and maintain standards of radioactivity to ensure that radiation measurements in the Research Establishment are consistent and accurate.

For Instrumentation displays visit Buildings 16 and 3 (Room 253).

Bldg. Room

16 T32A **ESTABLISHMENT OF COMMONWEALTH AND WORKING STANDARDS OF RADIOACTIVITY MEASUREMENT**

Cathode ray oscilloscope displays demonstrate counting plateau formations in gas-flow proportional counters and also the realisation of correct conditions for coincidence counting.

T32B **MAKING SUBMICROGRAM RADIOACTIVE SOURCES FOR USE IN GAS-FLOW PROPORTIONAL COUNTERS**

Radioactive material is deposited on gold-coated plastic supports less than two hundred-thousandths of a centimetre thick. The resulting sources may be seen through a stereomicroscope.

16 T32C

RADIOCHEMICAL TECHNIQUES FOR CHECKING THE RADIONUCLIDIC PURITY OF RADIOACTIVITY STANDARDS

An ion exchange column is used to separate a radionuclidic impurity from a radioactive solution. The progress of the separation is demonstrated with a multichannel gamma-ray spectrometer.

T51

NANOSECOND VERNIER CHRONOGRAPH.

This exhibit shows the developmental phase of a fast time-of-flight encoder of range 0 to 16 nanoseconds (one nanosecond is equal to one thousandth of a millionth of a second). The accuracy and long-term stability of this instrument is one nanosecond.

16 T51

BEAM DEFLECTION SYSTEM FOR THE 3 MILLION VOLT POSITIVE ION ACCELERATOR

The exhibit shows the developmental phase of an electrostatic deflection circuit for an ion beam. The deflection is controlled by a system in which light pulses are transmitted through perspex light pipes and received by photomultiplier detectors.

PORTABLE RATEMETER AND SCALER FOR MINERAL PROSPECTING

New designs of battery-operated portable instruments for detecting and counting radioactivity are on display. These are for field exploration for uranium and other minerals.

BETA-GAMMA RADIATION MONITOR AMPLIFIER

A simple amplifier using field effect transistors has been developed for use with standard ion chamber instruments in radiation detection.

NUCLEAR INSTRUMENTATION MODULE SYSTEM (NIM)

These units, some of AAEC design, illustrate the NIM system being used in the analysis of gamma-ray spectra. The NIM system is gaining in popularity because it is flexible and allows matching up of electronic units supplied by different manufacturers.

16 T51

DIGITAL INSTRUMENTATION

A small on-line computer is shown in operation.

T50

LOW NOISE AMPLIFICATION

An amplifier system using cooled-junction field effect transistors is used with silicon and germanium radiation detectors in high resolution X-ray and gamma-ray spectrometry.

NUCLEAR RADIATION DETECTION

At present the most highly resolving gamma-ray detectors are lithium-drifted germanium crystals. A large volume crystal housed in a liquid nitrogen cryostat is shown producing a spectrum of the gamma radiation being emitted from a radioactive source. In addition, a static display includes gas ionisation counters and scintillation counters as well as semiconductor detectors and materials.

3 253

ANALOGUE COMPUTER

This computer can simulate the dynamic behaviour of the HIFAR reactor, and simultaneously represent other smaller dynamic systems.

ENGINEERING RESEARCH DIVISION

INTRODUCTION

Nuclear power reactors produce heat energy which is eventually converted to electricity. Engineering Research Division is studying the manner in which coolants remove this heat from the fuel elements in the reactor core; the Division therefore does basic and applied research on heat transfer and fluid flow mechanisms.

In a reactor core, exacting demands are placed upon the materials used in major components, fuel and fuel cladding. The materials must not only maintain their chemical and physical properties under operational conditions, but also have good thermal properties and be chemically compatible with the reactor coolant. Nuclear and thermodynamic performance of fuel and core components, therefore, must be assessed as an integrated problem. This requires co-ordination of studies in engineering, reactor physics and materials science.

To simulate reactor conditions, a variety of test rigs have been designed, built and operated. The rigs are providing basic information on the performance of reactor components, as well as data for the comparison and evaluation of various concepts and designs.

Much of this work entails the use of computers. The Division is progressively automating the acquisition and processing of experimental data.

For Engineering Research exhibits visit Building 3.

The principal exhibits are in the Main Bay and adjacent rooms. On the upper floor, two small laboratories (Rooms 258 and 259) and the Conference Room are open for inspection.

Bldg. Room

3 Engineering Research Main Bay

REACTOR HEAT REMOVAL

Just inside the entrance door of the Main Bay there is a diagram of a generalised power reactor scheme which demonstrates the various points at which factors affecting heat removal have to be investigated and evaluated. An associated plan of the laboratory indicates the location of those topics on which research is in progress or planned.

3 On right at entrance to Main Bay

GAS COOLING

This work is relevant to all gas-cooled reactors, including gas-cooled fast reactors, the pebble bed and other high temperature thermal reactor concepts, to the steam side of steam-raising units, and to nuclear superheaters for direct cycle boiling water reactors. Facilities include:

MECHANICAL DEVELOPMENT MODEL OF A SPECULATIVE HIGH-TEMPERATURE PEBBLE-BED REACTOR OF SMALL POWER OUTPUT

This study derives from an earlier but much larger investigation of possible power-station reactors of the same class. The experiment investigates the problems of thermal cycling of pebble-bed reactor cores and the use of a gas turbine with a nuclear reactor. The model is heated by propane gas.

DEVELOPMENT OF PROPANE BURNERS

Burners are shown which have been developed for the above experiment and also for heating high pressure water for heat transfer experiments.

VISUALISATION OF THE STRUCTURE, MOBILITY AND FLOW OF PEBBLE-BEDS

The results of several years work are shown together with their current application to the small reactor concept listed above.

HIGH PRESSURE GAS LOOP

This is used for heat transfer measurements of gas-cooled (or heated) reactor (or boiler) components. The gas bearing circulator is demonstrated in component form.

LOW PRESSURE AIR TUNNEL

(See this exhibit and its description after the Freon 12 loop).

3 Centre of Main Bay

COOLANT/NEUTRON INTERACTIONS SUB-CRITICAL ASSEMBLY (ELSA*)

An assembly of natural uranium metal rods in a light-water moderator, together with an accelerator-type neutron generator, is used to investigate the

* *ELSA = Engineering Laboratory Sub-critical Assembly.*

effects of heat removal processes (especially two-phase-flow) upon the number of neutrons at any point. Methods of detecting boiling in operating power reactors may evolve from this work; also methods for the laboratory investigation of aspects of coolant processes in laboratory experiments, for example, steam voidage and bubble nucleation. Noise measurement techniques are important and the ISAC** device at the University of N.S.W. is in use in a collaborative investigation in this field.

3 Main laboratory area and new extension

WATER COOLING

In relation to heavy-water reactors, the Commission's main interest at present is in water cooling. Heavy- or light-water would be used in either the pressurised-water indirect cycle or the boiling-water direct cycle.

PARALLEL CHANNEL LOOP

This is an atmospheric-pressure Freon 113 loop made mainly of glass tubing. It permits the visualisation of various types of loop instabilities occurring in two-phase-flow systems (that is, vapour and liquid).

FREON 12 LOOP

This loop has a nominal circulation rate of 85 gallons per minute, a working pressure up to 300 pounds per in^2 gauge, and a power input up to half a megawatt. It is used to develop scaling laws for critical heat flux (CHF) and other two-phase-flow processes by fluid-to-fluid modelling. Freon 12 (dichlorodifluoromethane) is used as a model for water because the loop can be operated at lower power and pressure. Measurements of critical heat flux in tube, annulus and rod cluster geometry are planned. The development of devices for the raising of the critical heat flux limit is also to be investigated.

NOTE: At this point examine the **low pressure air tunnel** referred to under Gas-Cooling.

Three low-pressure blowers (120, 60 and 35 hp) are available to provide an air supply for a variety of possible air-flow experimental arrangements. The exhibit shows the measurement of average heat transfer coefficients using the cyclic heating technique.

** *ISAC = Instrument for Statistical Analogue Computation.*

Measurements are made on packed beds, and on banks of tubes as for heat exchangers or reactor fuel rod bundles.

3 Engineering research bay

HIGH PRESSURE WATER LOOP

The medium sized loop capable of flows up to 16 gallons per minute and pressures up to 2,500 pounds per in^2 (later 4,000 if required) enables heat transfer and critical heat flux measurements to be made for water in all modes of conceivable interest for reactor heat removal. This loop uses two three-cylinder positive displacement pumps to give a very large available circulating effort for high pressure drop experiments. Associated with this loop is an out-of-reactor replica of a fuel element testing loop for HIFAR. It is used for heater development and instrument calibration.

THERMAL CONTACT RESISTANCE

The flow of heat from fuel bodies (pellets) to the fuel cladding (can) is an important part of the heat removal process. An electrically heated replica of a fuel element is being developed to enable the fuel-to-cladding temperature difference to be investigated by installing the replica unit in one of the high pressure water rigs.

LARGE STORAGE CELLS

The Division has more than 500 ex-submarine lead-acid storage cells which were surplus to Navy requirements. These will be used to supply very large inputs of direct current to various heat transfer rigs, especially the proposed multi-megawatt loop. This will be used with a full-size, full-power replica of a water cooled reactor channel and will require one to ten megawatts of power for short periods. The cells are recharged overnight by the regulator-transformer-rectifier sets which are associated by day with the critical heat flux rigs. This power is controlled with equipment salvaged from the Brisbane tramways. Only a third of the cells are on view, in a temporary location.

SMALL WATER LOOP

The small size loop uses a three gallon per minute (nominal) rotodynamic pump and operates as a closed loop up to 1,000 pounds per in^2. It will be used for development of instruments and other loop components and for basic investigations of system stability.

3

WATER TUNNEL

A 100 hp 3,000 gallon per minute pump circulates water around a closed loop with a nominal nine inch diameter circular test section. This apparatus has a wide application in hydraulic investigations and is being used at present for flow distribution and pressure drop tests on HIFAR fuel elements.

FUEL ELEMENT VIBRATION RIG

A 15 hp pump circulates water through an exact replica of a HIFAR fuel element. Fuel element vibrations are monitored by accelerometers and strain gauges whose outputs are recorded continuously.

MANOMETER LABORATORY

Measurements of pressure often call for the use of mercury manometers. A mercury still is on display.

3 258

STEAM QUALITY MEASUREMENT

An air-water mixture is used in a transparent plastic model to simulate a steam-water flow for the purpose of investigating the operation of a steam quality meter for the fuel-pin testing loop in HIFAR.

3 259

CAPACITY-TYPE VOIDAGE GAUGE

An air-water mixture is being used to test the performance of an electric-capacity type of voidage meter intended for the measurement of voidage in steam-water systems.

Conference Room

DISPLAYS ILLUSTRATING POWER REACTOR SYSTEMS

MATERIALS DIVISION

INTRODUCTION

Broadly, Materials Division is concerned with research into nuclear materials in relation to the development of a nuclear energy industry in Australia. Most of the research is project-oriented and the main emphasis is on the materials technology of heavy-water moderated, power reactor systems. Two of the main materials of interest are uranium dioxide (UO_2) which is used as the fuel, and zirconium alloys which are used as the structural materials because they do not wastefully absorb neutrons (these alloys have a low neutron capture cross section), and they have good resistance to corrosion in high pressure water, e.g. for fuel element cladding, pressure tubes, support grids, etc.

Some effort is devoted also to developing beryllia-based (BeO) fuel for high temperature gas-cooled reactors.

Apart from project-oriented research, a small team uses the research reactor HIFAR for fundamental studies of the solid state of matter. Other small teams do speculative research on new processes and products which could be of commercial significance in nuclear and general industrial technology.

The work covers a wide spectrum ranging from basic studies of phenomena through to technological development of processes. Some fields covered are surface chemistry, ceramic science and technology, physical metallurgy, radiation damage, corrosion and oxidation, mechanical behaviour of solids, in-reactor experimentation and handling of highly irradiated materials, fabrication of metals and ceramics, solid state physics, and chemical engineering related to the purification, separation and processing of raw materials and spent nuclear fuels.

The Division has a staff of about 100 of whom roughly half are professionally qualified in ceramics, metallurgy, chemistry, physics or chemical engineering.

For Materials exhibits visit Buildings 2, 3, 30, 41, 58.

2 North Wing — Chemical Engineering Main Bay South east corner

ENGINEERING SCALE EQUIPMENT FOR THE PRODUCTION OF NUCLEAR GRADE URANIUM DIOXIDE (UO_2) FROM URANIUM ORE CONCENTRATES

The equipment on display includes a stainless steel dissolver, mixer settlers; a precipitator, a rotary drum vacuum filter, a spray drier, a pulsed fluidised bed chemical reactor and general powder handling facilities. This equipment is used in a research program which aims to produce nuclear grade uranium dioxide from Australian ore concentrates, to improve the technology in selected stages of the process, and to investigate new methods of production.

South west corner

SOLVENT EXTRACTION MICRO-PILOT PLANT

This equipment will be used for development of solvent extraction processes to recover uranium, thorium and plutonium from solutions of radioactive nuclear fuel material. These methods could be used to reprocess spent fuel from nuclear power reactors. Banks of Westlake mixer-settlers are installed in glove-box enclosures shielded with lead bricks four inches thick and operated remotely. Flowsheets have been tested in this plant with activity levels up to about five curies/litre.

North west corner

RADIOISOTOPE SEPARATION CAVE

This facility is used to investigate processes for the separation of radioisotopes from irradiated uranium 235 with a view to future use of such processes in radioisotope production systems. Equipment has been installed for the separation of molybdenum 99 from short-cooled fission products formed by the irradiation of uranium dioxide. Production is approximately three curies/week of molybdenum 99. This is purified, packaged and distributed to Australian hospitals by the Commission's Isotope Division.

North wing — C147, 148

FABRICATION OF CERAMICS FROM COLLOIDAL OXIDES

An exhibit shows the processes and equipment used in the fabrication of ceramics by a recently developed technique in which ceramic oxide sols are continuously concentrated and extruded. Displays illustrate the steps of powder production, sol preparation, concentration and extrusion, and sintering. The equipment

used to study the structural changes which occur during this process is also on display. This includes:

2 — C147 148

A micromerograph

Used for the measurement of particle size distribution of powders.

A mercury porosimeter

Together with nitrogen absorption apparatus, is used for the measurement of pore size distribution.

A dilatometer

This is used for the measurement of shrinkage rates during sintering.

3 — 110

HIGH TEMPERATURE THERMAL CONDUCTIVITY MEASUREMENT

The equipment displayed enables thermal conductivities in the temperature range 300°C to 1500°C to be measured. Two units are used. The first is a "radial flow" unit which gives accurate absolute measurements, but requires specially-shaped specimens over two inches in diameter and is very slow in operation. The second unit (not yet completely developed) is a "flash" type which allows quick measurements on small, thin discs in a vacuum furnace. A pulse of radiant energy is focused on one face of the disc producing a temperature transient on the other face. The transient is detected by a photomultiplier and displayed on a storage oscilloscope.

3 — 108 and 110

OXIDATION OF ZIRCONIUM

Work illustrated here is designed to obtain a better understanding of the corrosion mechanisms of zirconium alloys in water-cooled reactors. Electrochemical measurements on oxide films are made in room 108 and stress measurements on oxide films are related to corrosion rate (room 110).

3 — 132

MECHANICAL BEHAVIOUR OF ZIRCONIUM

Work in this area is concerned with the mechanical behaviour of zirconium for application in reactors. A display of some of the results of this work is presented and a Tinius Olsen testing machine is set up for producing stress versus strain plots at elevated temperatures *in vacuo*.

1st floor 205, 210

OPTICAL MICROSCOPY

Metallic and ceramic specimens are polished and examined by reflected light microscopy to reveal their microstructure which strongly influences mechanical properties. Examples of various microstructures of nuclear fuels and structural materials are shown. Instruments on display include vibratory polishing equipment, optical microscopes and a micro-hardness tester.

212

X-RAY DIFFRACTION

X-rays are scattered by the electron clouds of atoms, and diffracted beams can be obtained depending on the geometry of the experiment and the arrangement of atoms in a crystal. The results of X-ray diffraction studies can be analysed to reveal the positions of atoms in crystalline solids as well as to give information about the size, shape and orientation of the unit cell. This technique is a valuable tool for investigating the lattice damage in materials exposed to neutron irradiation. Instruments on display include X-ray generators, various diffraction cameras, counter tube diffractometers and a texture goniometer.

213, 214

TRANSMISSION ELECTRON MICROSCOPY

Under favourable conditions, the electron microscope can resolve detail approaching interatomic distances. This technique permits direct observation of crystal defects in materials exposed to neutrons, as well as dislocations which exert a major influence on the mechanical behaviour of materials. Examples of dislocation structures in irradiated and unirradiated zirconium are shown. (This equipment is also used to examine the ultrastructure of cells in biological studies.)

Instruments on display include the JEM-7A, Siemens Elmiskop I and Hitachi HS7 electron microscopes.

NUCLEAR MATERIALS FABRICATION LABORATORY

3 Nuclear Materials Fabrication Bay

This laboratory is equipped for research and development on the fabrication of materials for use in reactors. These include uranium and thorium metals, zirconium alloys, uranium dioxide and beryllium oxide. Major items on display are:

3 West side of Bay

BERYLLIUM OXIDE POWDER PREPARATION

Equipment includes a vibro-energy mill and vibroscreen, vacuum drying oven and blender.

CONTINUOUS SINTERING FURNACE

A pusher type furnace, for use in air to 1500°C.

ROLLING MILL

100 hp mill with 10 inch diameter rolls. This is used for rolling zirconium, uranium, thorium and beryllium billets into sheet.

UO_2 POWDER PREPARATION AND PRESSING EQUIPMENT

A 20-ton hydraulic press is shown producing uranium dioxide (UO_2) pellets of the type used as fuel in heavy-water moderated power reactors.

East Side of Bay

NUCLEAR MATERIALS MACHINE SHOP

HYDRAULIC PRESS

1,000-ton press capable of high-speed extrusion, forging or pressing.

DISPLAY OF FUEL ELEMENT FABRICATION

This shows the components of a Zircaloy-clad UO_2 fuel element and the fabrication methods used in its manufacture.

COLD-DRAWING BENCH

This is used for a study of the fabrication of zirconium alloy tubing.

VACUUM MELTING FURNACE

Capable of melting and casting up to 200 kilograms of metal.

3 East Side of Bay

UO_2 SINTERING EQUIPMENT

This includes two large hydrogen-atmosphere furnaces for continuous sintering of uranium dioxide (UO_2) pellets. Heating elements are of molybdenum and a hydrogen atmosphere is used to protect these and the UO_2 from oxidation.

3 — Enter from South end of Bay

NEWLY COMPLETED NUCLEAR MATERIALS FABRICATION BUILDING

Visitors are invited to walk through to this new building and inspect the display in the ceramics processing area, illustrating future plans. When fully occupied it will comprise nuclear materials stores, offices, change rooms, and a ceramics fabrication open bay, where uranium oxide pellets will be fabricated on a pilot-plant scale. All uranium oxide and beryllium oxide work will be moved here from the Building 3 Nuclear Materials Fabrication Bay which will then be devoted entirely to the fabrication of zirconium alloys, assembly of complete fuel elements, and the melting and casting of uranium and other metals.

30

RADIOGRAPHIC EXAMINATION

Equipment used in examination of materials is shown including low-voltage X-ray and gamma-ray radiography. The technique is useful for detecting leaks in welds, defects in fuel elements, etc.

ULTRASONIC EQUIPMENT

For examination of materials to detect flaws of various types.

SPECIALIST WELDING EQUIPMENT

Used for reactive metals.

41

HOT CELL BLOCK 1

(See page 37.)

58

X-RAY DIFFRACTION

These exhibits are described under Operations Division because they are near the reactor HIFAR.

(See page 38.)

CHEMISTRY DIVISION

INTRODUCTION

The Chemistry Division does research on chemical problems connected with:

(a) the operation of nuclear reactors,
(b) provision of raw materials such as fuel and moderators for these reactors, and
(c) reprocessing of used fuel elements to recover valuable materials.

The Division also provides a chemical analysis service for all other Divisions and, since the tasks involved are extremely varied and often unusual, much of the analytical effort is devoted to research and development.

Some additional research is done in chemical fields not directly connected with operation of reactors but for which Lucas Heights has facilities unique in Australia. Such investigations include the study of chemical structure using neutron diffraction techniques, the determination of trace elements by neutron activation analysis, the precise measurement of isotopic ratios using mass spectrometry, and the study of the basic chemistry of the actinide elements.

For Chemistry Division exhibits visit Buildings 2, 24.

Bldg. Room

2 — C114, 115

MANUFACTURE OF SCIENTIFIC GLASSWARE

The Research Establishment has a glass workshop to manufacture the special kinds of glassware required for experiments.

C109

CONTROLLED POTENTIAL POLAROGRAPH-VOLTAMMETER

This instrument is used to determine traces of many metals in solution.

C221

TECHNICON AUTO-ANALYSER

Used for the automatic determination of uranium.

2 C221 **HERSCH MARK 2 OXYGEN METER**

For measuring low levels of oxygen in water.

C222 **SPECTROGRAPH AND FLAME SPECTROPHOTOMETER**

This equipment is used for rapid routine analysis of many materials.

C189 **WATER LOOPS**

These are used to study the corrosion of aluminium and zirconium in a controlled aqueous environment.

ELECTROCHEMISTRY

Chemical studies are made of the rate of corrosion of metals in solution and the stability of the oxide layer.

C167 **TRANSURANIUM (ACTINIDE) CHEMISTRY**

These laboratories are closed to visitors because of radioactivity hazards but the glovebox facilities, which enable various chemical operations to be performed safely, can be seen through the windows.

C170 **NUCLEAR AND ELECTRON MAGNETIC RESONANCE**

In this work the structure of solids, and radiation effects in liquids and solids are studied.

C171 **MASS SPECTROMETERS**

Gas and solid-source mass spectrometers are used for the analysis of gases and isotopes.

2 South Wing C173 **INFRARED SPECTROSCOPY**

High resolution spectrophotometers are used to investigate the structure, composition and thermal decomposition of uranium compounds, and the surface chemistry of ceramic oxides of uranium and thorium (UO_2 and ThO_2).

C175, 176 **DIFFERENTIAL THERMAL ANALYSIS AND THERMOGRAVIMETRIC ANALYSIS**

Used to study the chemistry of uranium dioxide (UO_2) production. Equipment includes Cahn RG and RH electrobalances with associated data-logging equipment.

Note: Chemistry Division has additional analytical equipment on display in Building 24 near the reactor HIFAR. It is described under Operations Division.

PHYSICS DIVISION

INTRODUCTION

Physics Division conducts a program of research along two main lines:

(a) Project oriented research connected with heavy-water moderated power reactors.

(b) A deeper, more speculative approach to gain an increased understanding of the physics of reactors.

To support such a program, the Division is divided into three sections:

Experimental Physics

The main experimental facilities used by this section are a 3 million volt positive ion accelerator and the low power research reactor Moata (An aboriginal word meaning fire-sticks or slow heat). The accelerator produces a beam of positive ions — usually protons or deuterons—which can be continuous, modulated or pulsed. Its chief application is the production of neutron beams with characteristics suitable for detailed measurements on neutron interactions with matter.

Moata has been used for studying combinations of fissile, fertile and moderating materials such as may be used in a reactor core. However, other more flexible equipment is being designed for this purpose and Moata is now used to generate beams of neutrons for further experiments on neutron interactions with matter. Data from the detectors used in experiments with the accelerator and Moata are gathered by a PDP-7 on-line computer.

Visitors are invited to inspect these facilities from the balcony above the main bay in Building 22 and to examine the displays depicting various aspects of the experimental program.

Theoretical Physics

This section investigates theories which may be used to collate the experimental information gained from experiments with neutrons. Studies also include theoretical investigation of reactor behaviour. The aim is to provide a library of data which can be used with various theories to predict the behaviour of a nuclear reactor by complex calculational techniques using digital computers.

Applied Mathematics and Computing Section

This section operates the AAEC's large IBM 360/50H digital computer. It also advises Establishment staff on computer techniques, undertakes special projects requiring expert programming knowledge, and does research on the application of computer techniques to the field of nuclear energy.

For Physics Division exhibits visit Buildings 22, 55 and 51 (Computer Building).

Bldg. 22 Room Main Bay

3 MILLION VOLT POSITIVE ION ACCELERATOR

In this installation a Van de Graaff electrostatic generator is used to provide 3 million volts across a special tube through which the ions are accelerated in a vacuum. The fast-moving ions, usually protons or deuterons, produce neutrons by bombarding lithium or beryllium targets inside the evacuated beam tube. A model and a scale diagram show the principle of operation.

NEUTRON EXPERIMENTS

The emphasis in the accelerator research program is on neutron processes of basic significance in the design and operation of reactors.

Fission

This is the reaction which liberates nuclear energy in reactors. A large liquid scintillator neutron detector is used to study the average number of neutrons released per fission event, and the variation of this number with the energy of the initiating neutron.

Neutron transport and slowing down

Because the ability of neutrons to induce fission in uranium depends on their energy, it is necessary to understand the manner in which they lose energy. A burst of neutrons lasting for microseconds is produced by the accelerator at the edge of a stack of beryllium oxide. As the neutrons slow down and diffuse through the stack, measurements are made of flux and energy using solid state detectors and a time-of-flight spectrometer.

22 Main Bay

Neutron capture

In a reactor, neutron capture reduces the number of neutrons available to induce more fissions and the probability of such capture must be known. On the other hand, neutron capture experiments can give insight into the structure of the atomic nucleus. If very short (10 nano seconds which equals 10^{-8} seconds) bursts of neutrons produced with the accelerator are directed onto a target, some of the neutrons in each burst are captured by target atoms.

Each capture event produces an unstable condition in the nucleus which emits gamma-rays as it settles down to a stable state. The gamma-ray energies are characteristic of the nucleus and are detected with a germanium crystal. The characteristic gamma-ray energies, together with neutron energies obtained from time-of-flight data, give basic information about the newly formed nucleus. The systematic study of such information is important in predicting reactor shield performance.

Other studies

The accelerator facilities are made available to groups from other divisions and the universities for work requiring ion beams. Projects include proton microanalysis, charged particle reaction studies, proton channeling, neutron radiation damage and production of special tracer radioisotopes for biological research.

PDP-7 DATA ACQUISITION SYSTEM

The use of this system for various tasks will be demonstrated. In most of the above-mentioned experiments, the data are obtained in the form of electrical pulses whose amplitude, width or time of occurrence give information about the experiment. The signals require amplification and shaping before the results are stored. The latest equipment for doing this is fully transistorised and modular, as shown in the display. The task of converting the pulse parameters to numbers, storing them and making them available in more convenient form for the experimenter, is handled by the PDP-7 computer.

MOATA

This is a reactor with a power of 10,000 watts, moderated and cooled with ordinary water. It uses fuel elements consisting of a uranium 235-aluminium alloy. Neutron fluxes up to 10^{11} neutrons/cm^2 per second are available for irradiation and activation uses. The prime use has been the study of the physics of other reactor systems, though it is now used for a variety of beam experiments. A start-up of the reactor begins each day at 9.30 a.m. and the following experimental equipment is operational:

22 North Face of Moata

Pneumatic oscillator

The rate of change of the neutron flux is observed when small specimens of material are transferred between a fixed position inside the reactor and a position outside the reactor. The difference between observations is a function of the nuclear properties of the specimen. Various methods of data recording are shown.

Time-of-flight spectrometer

This measures the neutron distribution with respect to energy (similar to measuring the distribution of height or income for people) by observing the time taken to travel a fixed distance. The time analysis of the detected events is electronically converted to an energy spectrum of the neutron beam.

Static displays

Photographs, line diagrams and samples of equipment show various aspects of facilities, tools, and past and present experiments. One display outlines the steps involved in proceeding from data on the basic structure and properties of atomic nuclei to the calculation of the properties of a nuclear reactor.

55 Theatre

FILMS

For full details of film program in this theatre see page 5.

51 18

IBM 360 MODEL 50H DIGITAL COMPUTING SYSTEM

The main use of the computer is to help physicists and engineers in the analysis and design of possible reactor systems. They usually write their own programs in the scientific programming language FORTRAN IV. The computer is also used to analyse results compiled by smaller computers within the Research Establishment, and for accounting and payroll purposes.

51 18

The computing system consists of a large IBM digital computer made up of the following units:

In the centre of the room, facing the door, is the IBM Model 50 **central processing unit.** The lights on this unit indicate the areas of the computer system which are activated by programs being run.

Attached to the central processing unit is the **magnetic core storage** (in the large cabinets). This can store up to 262,144 characters of information at any one time. Access to the information in this core can be obtained by the central processing unit at an internal cycle time of two millionths of a second.

In front of the central processing unit is an **electric typewriter** which is used for transmitting messages and commands from the operator to the computer and vice versa.

On the left are four 2311 **magnetic disk drives.** On each of these is mounted a disk pack consisting of six 16 inch diameter disks coated with magnetic material. Each disk pack can hold 7,250,000 characters of information which can be accessed either sequentially or randomly. The information can be transferred to and from the central processing unit at a rate of 156,000 characters per second. Behind the disk drives are two **control units,** each controlling two drives.

Alongside the disk drives are two 2400 **tape drives** and their **control unit.** Each tape drive can hold a ½ inch wide magnetic tape up to 2,400 feet long. Such a tape can hold up to 18 million characters of information which can be transferred to the central processor at a rate of 60,000 characters per second.

Behind the tape drives are the large cabinets holding the **magnetic tape library.** This is used by Commission staff for storage of data from research work.

On the right hand side of the room is the 1403 **line printer,** capable of printing 132-character lines at the rate of 1,100 lines per minute.

Between the printer and the central processor is the 2540 **input card reader** and **output card punch.** This unit can read punched cards at a rate of 1,000 per minute and can punch cards at a rate of 300 per minute. Behind the card reader-punch is the control unit for these devices.

On the far right of the room is the 2671 **paper tape reader** which is capable of reading punched paper tape at a rate of 1,000 characters per second.

HEALTH AND SAFETY DIVISION

INTRODUCTION

The Health and Safety Division has two main functions — to ensure safe operation of the Research Establishment, and to do research which has a bearing on safety.

Safe operation of a nuclear establishment necessitates the provision of operational health physics services wherever radiation sources or radioactive materials are in use. The services, which are provided by the Safety Section, include surveys for radiation hazards, monitoring of personnel and measurement of radiation dose, advice on radiological hazards and the investigation of accidents. The Division is also concerned with all types of industrial hazard. A medical group provides an industrial medical service, specialist advice and facilities for dealing with any radioactive contamination of staff.

In research, the questions which a health physicist or radiation biologist must try to answer include how, and in what amounts, does radiation reach a person at risk, how does it produce harmful effects on living organisms, what are these effects and can they be modified; what use can be made of them, as in radiotherapy, and finally, what is the precise form of the dose-response relationship for the various biological effects of radiation.

For Health and Safety exhibits visit Buildings 21 and 8.

Bldg. Room

8

FIRE AND INDUSTRIAL SAFETY SERVICES

A display of fire and emergency vehicles, fire-fighting equipment, various kinds of respiratory equipment and industrial safety equipment.

21 Foyer

OPERATIONAL HEALTH PHYSICS MONITORING EQUIPMENT

A display of radiation monitors and measuring equipment, instruments for measuring airborne contamination, and alpha and beta counting equipment.

21 39

PERSONNEL DOSIMETRY

This display includes equipment for photographic and thermoluminescent dosimetry and other devices for monitoring the radiation dose to personnel.

21 53

RADIATION DOSIMETRY STANDARDS

National and international standard units of radiation dose are established by law. This display shows a series of instruments used to provide suitable standards for accurate measurement of dose.

21 51

STUDIES OF THE SLOWING DOWN OF PARTICLES

In a facility under construction, heavy ions will be accelerated to energies up to 140 keV and their masses analysed. The accelerator will be used to study aspects of the phenomena which occur during the slowing down of energetic particles in matter by successive collisions.

21 49

ALPHA-SPECTROMETRY AT LOW SPECIFIC ACTIVITY

An alpha-spectrometer using an ion chamber of large area (2,500 cm^2) is used to determine the very low levels of alpha emitting elements that occur naturally in environmental and biological materials.

21 72

HISTOLOGICAL LABORATORY

Histology is the study of fine details of tissues and organs. In this display, investigations into respiratory pathology and other work are explained. Histological equipment is shown and material under the light microscope and electron microscope illustrated.

21 77

CELLULAR PHYSIOLOGY OF A MARINE ORGANISM

Apparatus and methods used in studying the movement of ions in single-celled algae are exhibited. A series of photomicrographs of osmotic changes in progress in the organism *Dunaliella* is on view.

21 78

SOME TECHNIQUES USED IN RADIOBIOLOGY

Tissue culture studies

Animal cells, adapted to grow outside the living organism, are now one of the main tools in radiobiological studies. Populations of such cells behave very much like the same cells in the intact animal when irradiated, providing a convenient method for investigating radiation injury to cells. Displays show details of methods used to measure cell survival after radiation and for determining chromosome aberrations.

21 78

AUTORADIOGRAPHY USED TO STUDY DNA SYNTHESIS IN LIVING CELLS

Changes in the ability of mammalian cells to synthesise DNA can be followed easily by autoradiography. This is the technique of locating radioactive materials by exposing them to film, and successive steps in the process are shown. If one of the materials that go to make up the basic biological material DNA is labelled with a radioactive substance, changes in its rate of incorporation into DNA can be detected. The labelled substance used in this case is tritiated thymidine.

21 59

STUDIES IN RADIOBIOLOGY AND RADIATION DOSIMETRY

Chromosome aberrations

The displays indicate the relation between radiation exposure and the production of abnormalities in chromosomes in blood cells and how their measurement can be used to estimate radiation dose.

Relative biological effects of radiation

This display illustrates some investigations into the differing effects of various types of radiation on mammalian cells. Different radiations that deposit their energy by a variety of processes have differing effects even though the absorbed dose is the same.

21 57

SAMPLING AND ABSORPTION OF RADIOACTIVE IODINE

This display includes an explanation of the behaviour of iodine in the atmosphere, a static display of iodine samplers and an explanation of differential sampling, a static display of a controlled-humidity iodine sampling chamber, a static display of a full-size charcoal bed loading device, and a working display of a small scale charcoal bed loading device.

21 Annexe at rear of Main Building

WHOLE-BODY COUNTER

This facility consists of a gamma spectrometer using a large sodium iodide crystal as a scintillation counter, in a room which is heavily shielded from the effects of external radiation. This equipment is used to measure very small amounts of gamma-emitting isotopes in the human body. Examples are shown of measurements of radioactivity in persons examined in the counter.

OPERATIONS DIVISION

INTRODUCTION

Operations Division is responsible for the safe and efficient operation of the high flux materials testing reactor HIFAR. This involves:

(a) Three shift operation of reactor plant and controls as well as the many experimental rigs and facilities within the reactor that arise from the research program and isotope production.

(b) Programming and reporting on each four-weekly cycle of operation.

(c) Routine handling of radioactive materials such as used uranium fuel elements and radioisotopes.

(d) Preventive maintenance of plant.

(e) Assessment and modification of reactor plant.

(f) Calculation and measurement of burn-up of fuel and changes in reactivity of the core as fuel is used and reactor loading varied, and determination of neutron flux and other physical characteristics of the reactor.

The Division is responsible for supplying other Divisions with special equipment which normally cannot be purchased. This responsibility is an engineering function involving preliminary investigation, design and drafting, estimation of costs, analysis of tenders, supervision of contract work including manufacture by Research Establishment workshops, testing and inspection, acceptance and final commissioning.

The Division is also responsible for the design and construction of new buildings and associated facilities, the modification and maintenance of existing buildings, and laboratory and plant operations. Specialised services and facilities are provided for the handling, storage and disposal of radioactive and toxic waste and for the control of radioactive contamination.

For Operations Division exhibits visit Buildings 3, 12, 15, 25, 40, 41. Also included is Building 24 (Chemistry Division exhibit) and Building 58 (Materials Division exhibit).

25 Foyer

WORKS, ENGINEERING SERVICES AND SITE OPERATIONS

Buildings and facilities

The display features models of the Research Establishment and the Medium and High Level Waste Treatment Building. Drawings, diagrams and photographs show the design, construction and maintenance of the Research Establishment's buildings and facilities of particular interest to engineers, architects, scientists, quantity surveyors and contractors.

Landscaping

Drawings and coloured photographs are shown of typical landscaping development at the Establishment.

High density concrete for radiation shielding

Samples are shown of fine and coarse aggregates, such as steel shot, ilmenite sand, steel nut punchings and barytes, which are used in high density concrete. Sawn and broken high density concrete cylinders are on display. Types of blocks used in shielding and the method of building walls for maximum protection from radiation are illustrated.

ENGINEERING SERVICES EXHIBITS

(a) A model of a triple axis neutron spectrometer to be installed in HIFAR.

(b) Photographs of experimental equipment designed and manufactured by Operations Division for research Divisions.

(c) A sectioned model of an experimental rig used for irradiating materials in HIFAR.

25 1st Floor Landing

Examples of experimental equipment designed and manufactured for research Divisions.

1st Floor Drawing Office

Examples of design work in progress.

25 1st Floor Print and Records

Processing of drawings to produce film records and photo prints.

3 Main Workshop

Machine tools in use, including numerical control machines.

Inspection, planning and workshop loading processes in use.

12 Effluent Treatment Plant

SITE OPERATIONS

Here liquid effluent with a low level of radioactivity is treated to remove radioactivity prior to discharge from the Research Establishment into the Woronora River.

REACTOR OPERATIONS

In this section, details are given of arrangements for inspecting the Reactor group of buildings. Several other Divisions have exhibits in this area and these are included here.

The large, white, sealed building at the western end of the site houses the ten million watt (ten megawatt) research reactor HIFAR. The name is derived from the words High Flux Australian Reactor. The reactor building is open for inspection. It contains a large amount of complex but interesting equipment. Since HIFAR operates continuously and space is limited, a conducted tour has been arranged in parties of 15 people. The following arrangements will allow you to obtain a very good idea of the operation of a nuclear reactor.

INSPECTION OF HIFAR BUILDINGS AND REACTOR
ENTER AT BUILDING 41 (South entrance)

41 Hot Cell Block No. 1

High activity handling

This is a block of cells in which highly radioactive materials are handled behind heavy shielding. These materials are on display and the exhibit includes remote handling equipment such as Master-Slave Manipulators, and remote viewing equipment such as closed circuit television.

41 Active Handling Bay

Lecture

After viewing the hot cell block you may attend a short introductory lecture on the design principles and operation of HIFAR.

15 Sealed Building

REACTOR INSPECTION

Inspection parties of 15 persons will be formed in Building 41 at the HIFAR Inspection Assembly Area and will proceed at intervals through an air-lock and into the Reactor Sealed Building.

15

Visitors must follow the roped-in pathway through the building.

As you pass through the building you will see various items of reactor plant and the Control Room. Fuel handling equipment and radiation monitors are on display. You will also see the radioisotope self-service facilities and many neutron diffraction experiments. In these experiments some of the neutrons produced in HIFAR travel along a narrow pipe to be scattered by specimens of crystalline solids. The way in which they are scattered is recorded by neutron counters. From this we can learn about the atomic structure of the material. The neutrons are finally absorbed in a beam trap.

As you pass around the faces of the reactor you will see in order:

Long wavelength neutron scattering apparatus.

Small angle scattering apparatus.

A single crystal diffractometer.

An automatic single crystal diffractometer.

A triple axis spectrometer.

A powder diffractometer.

42 Air Lock

After passing through the Building 42 air lock you have left the Reactor Building proper and are invited to visit Building 58 (Materials Division) and Building 24 (Chemistry Division).

NEUTRON DIFFRACTION LABORATORY

(Materials Division)

The neutron diffraction laboratory is occupied by Materials Division and staff of the Australian Institute of Nuclear Science and Engineering (AINSE).

58 10

X-ray diffraction

X-ray diffraction apparatus is on display.

58 14

Display of experimental results

Results of experiments on display concern the analysis of structure of crystals, neutron scattering to find out more about the forces that bind atoms, magnetism and radiation damage.

15

Ancillary equipment

Furnaces, cryostats and magnets are on display.

ANALYTICAL CHEMISTRY LABORATORY

(Chemistry Division)

24

Analytical equipment

The display includes equipment for the analysis of gases, ordinary water and heavy-water. It involves infrared spectrometry and interferometry.

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NOTES

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