Harwell

Europe's largest centre for multi-disciplinary research and development

Working wit

Harwell is the research laboratory of the United Kingdom Atomic Energy Authority. Its expertise and nuclear facilities have been available for more than 25 years for use in the fields of nuclear research and in industrial, medical and environmental applications of radioisotopes.

In 1965 the Science and Technology Act enabled Harwell to undertake work outside the nuclear power field and to initiate contract R&D programmes in collaboration with commercial organizations. Today, although there is a continuing and substantial nuclear research programme, almost half the work undertaken by the Laboratory is now commercially oriented and involves liaison with a wide sector of industry and commerce.

The ever increasing complexity of present day technologies and the need for innovation and the development of new materials and processes have demanded facilities and expertise often beyond the financial and material resources of all but the very large organizations. There has developed, therefore, a need for a laboratory like Harwell where an organization can hire the available facilities and scientific back-up for as long as it wishes without having to embark on expensive in-house alternatives.

Harwell's income from contract R&D and the hire of its facilities is currently more than £27 million per annum and its clients range from the small private company to the giant multi-national.

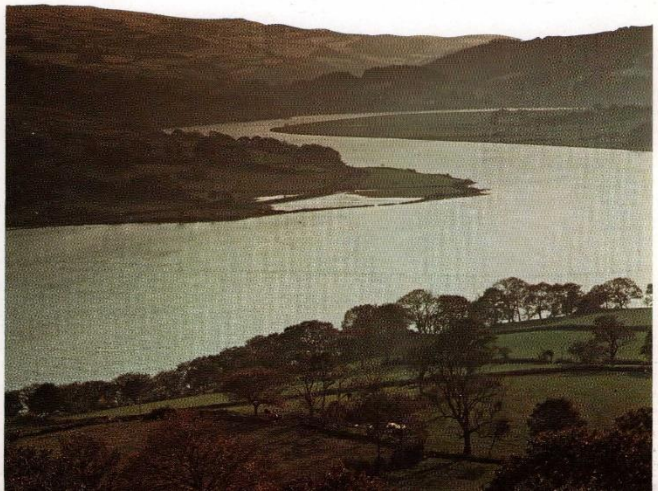
The Laboratory also undertakes long-term industrial research programmes which are supported by the Requirements Boards of various Government Departments.

Environmental Protection

The expansion of many industries and the introduction of new ones with new and unfamiliar processes has led to an increase in public concern about their effects on the environment. This concern is reflected in many Harwell programmes funded by Government Departments and by industry itself. One such programme, for the Department of the Environment, is aimed at understanding the life histories of pollutants in the atmosphere, particularly those of a carcinogenic nature. Other programmes involve studies of industrialised regions for local authorities who are introducing or managing 'clean air' programmes.

Local authorities also call upon Harwell's Environmental Safety and Chemical Analysis Group for advice on the management, storage and disposal of toxic and other dangerous wastes; and for help in cleaning up and reclaiming contaminated land and property. These services are also available to industry and many assignments have been successfully carried out for waste disposal contractors, chemical and pharmaceutical manufacturers and hospitals.

Anglesey *(Photo by courtesy of Shell UK Ltd.)* ▼



Emergency services

The National Chemical Emergency Centre at Harwell, set up by the Department of the Environment in 1974, provides advice to fire services and other emergency organisations on hazards associated with fires and transport accidents in which dangerous chemicals are involved; the Centre's facilities are also available to chemical manufacturers, transporters and traders.

Harwell maintains a continuously manned telephone service which provides advice to emergency services on behalf of companies who are subscribers to the service.

Tracers

Tracer measurements in coastal polluton ▲ studies.

The Harwell Flow Measurement Service has had many years experience in the use of radioisotope tracers for the detection of leaks in drainage systems, the location of underground storage pipes, coastal and estuarine sedimentation studies, the dispersal of effluent discharges and studies of groundwater movement. The Service also provides calibration and measurement facilities for air, water and high pressure gas flowmeters.

Typical programmes and services

- **Nondestructive Testing**
  X, gamma and neutron radiography
  Ultrasonic inspection
  Dynamic radiography of jet engines
  Rail track inspection
- **Laser Technology**
  Internal combustion engine research
  Vibration monitoring
  Anemometry & Interferometry
- **Engineering Sciences**
  Surface and submersible robots
  High temperature fluid flow
  Corrosion studies
  Offshore platform inspection
  Remote manipulators
- **Testing & Calibration Service**
  Electronic test instruments
  Pipe flow
  Pressure vessels
- **Metal and Chemical Technology**
  Surface and elemental composition
  Scanning electron microscopy
  Fatigue and fracture studies
  Semiconductor doping
  Fusion welding

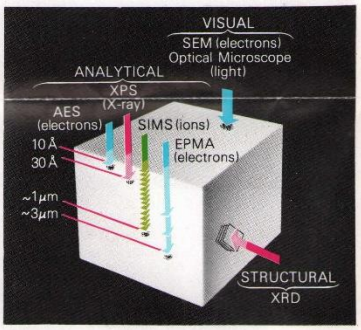
h Industry

Collaboration between British Rail and Harwell has resulted in the development of a fully automated track defect inspection system. ▼

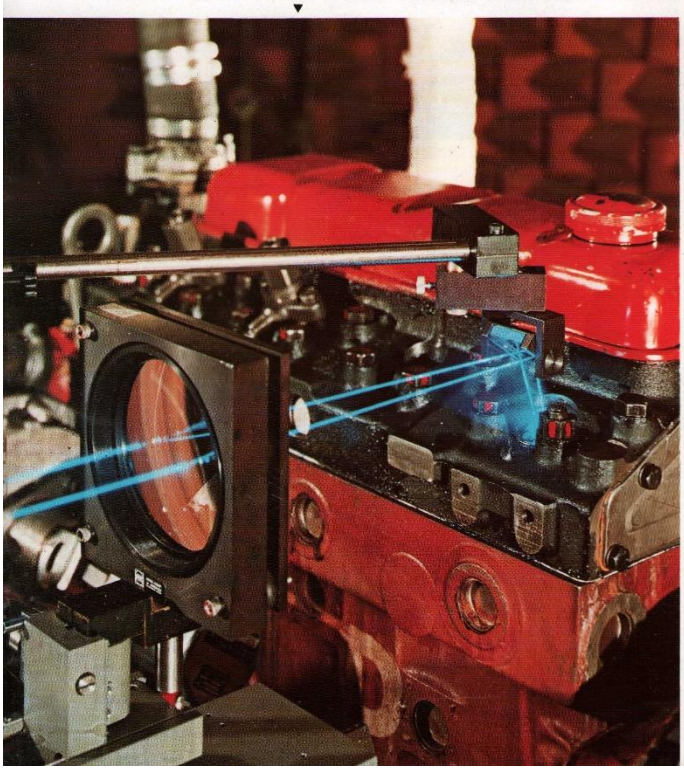
Dynamic radiography. An engineer prepares ▲ an RB211 engine for test at the Rolls-Royce Hucknall Test Facility *(Photo courtesy of Rolls-Royce Ltd.).*

SCAN was designed at Harwell for the Underwater Maintenance Company of Southampton. It is a remotely controlled submersible vehicle for visually inspecting the undersides of floating tankers. ▼

Summary of available techniques at Harwell ▶ for the examination of solids.



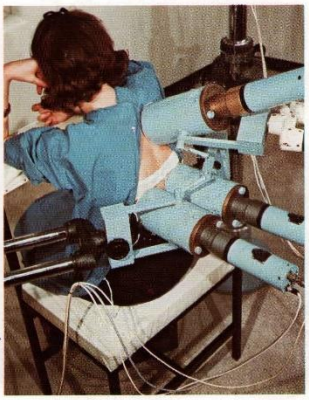
With the collaboration of Harwell's scientists, nuclear age laser technology is now being used within the British motor industry to analyse gas flow and combustion efficiency in internal combustion engines. ▼



Medical Programmes

Harwell's research in the medical field is not devoted exclusively to health physics and radiological protection, although such research continues to play a major role in the work undertaken at the Laboratory.

Many of the techniques developed for nuclear medicine have been adapted for the much broader field of non-nuclear medicine and include such topics as ultrasonic inspection of the human eye, the design of blood pressure analysers, and toxicity studies of various substances.



Measuring the uptake of iodine in the ▶ patient's kidneys using the radioisotope I-131 and 2 radiation detectors (one for each kidney).

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Support to Government Departments

▲ Production Platform, FC (Highland One) in BP's Forties oilfield in the North Sea. *(Photo courtesy of British Petroleum).*

Two Support Units have been set up at Harwell to supervise and control contracts initiated by government departments for R&D in the offshore industry and in the evaluation of renewable energy sources.

The first of these units, The Marine Technology Support Unit (MATSU), was set up in 1968. Its task has been to identify R&D requirements for the offshore industry and to advise where government funding should be applied. It is also responsible for the monitoring and supervision of work associated with contracts placed by the Department.

The Energy Technology Support Unit (ETSU) was set up in 1974 and operates as an agency for the Department of Energy. Its responsibilities include the assessment, initiation and management of research, development and demonstration of renewable energy sources (sun, wind, waves, tides etc.) and energy conservation, and assistance to the Department's Chief Scientist to develop an overall energy R&D strategy for the UK.

The U.K.

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Nuclear Stations is com
Nuclear Power will be prov

Nuclear Power Programme

tain's electricity is now provided by Nuclear Power.
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pleted. By the turn of the century it is estimated that
ding about half of the country's electricity requirements.

Much of the R&D which contributed to the success of the present nuclear power stations was carried out at Harwell. Studies and experiments are continuing with the aims of improving the operating efficiency, long-term reliability and overall safety of these stations, and of other types which may be introduced in the future.

This is especially true of the proposed commercial fast reactor which would introduce a 50-fold improvement over the fuel burning efficiencies of the reactors used in the existing types of stations and which would burn-up the plutonium which they produce.

◀ Fuel element loading process in the core of the prototype fast reactor (PFR) at Dounreay.

Materials

The fuel, its cladding, the coolant, moderator, radiation shield and structural materials within the core of a nuclear reactor are continually subjected to intense heat, pressure and nuclear radiation. Such hostile conditions can lead to swelling, corrosion and embrittlement of the materials used for these applications and the integrity of their structural and physical properties has a marked effect on the operating efficency and safety of the reactor.

Because of the unusually high demands made on reactor materials, the Harwell Laboratory devotes much of its resources to research on the behaviour of materials and to developing new ones. Such work will continue to provide a major contribution to the continued success of Britain's nuclear power programme.

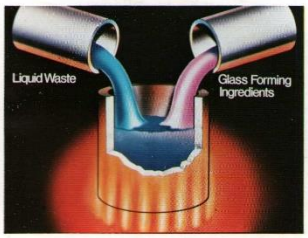
◀ A view of the interior of Harwell's 6 million volt Van de Graaff accelerator. The machine is used for research into ion implantation, radiobiology and the effects of radiation damage in materials.

Safety

The hazards associated with radioactive materials have been appreciated since the days of Madam Curie. Because of this, an essential feature of the UK nuclear power programme has been the development of efficient plant monitoring and radiological protection instruments to ensure the safe operation of reactor operating systems and to safeguard the health of the general public and of people working with radioactive materials.

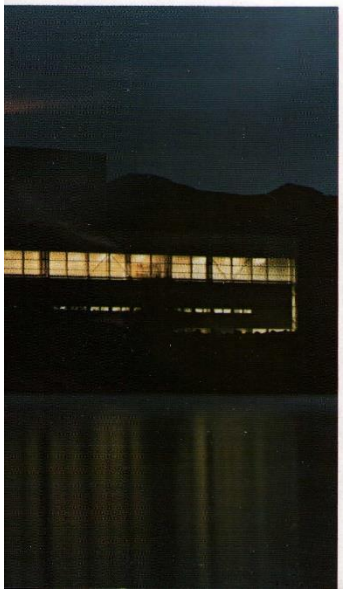
Considerable effort at Harwell is devoted to obtaining a better understanding of the toxicity of radioactive elements and of the effects of nuclear radiation on materials and living tissue, and on the continued development of safety procedures and mechanisms for nuclear plant control.

▲ The location of: ● UKAEA and BNFL sites ■ nuclear power stations



In the Harwell vitrification process, glass ▲ forming chemicals are mixed with highly active waste liquid and heated in a vitrification furnace to produce blocks of glass clad in stainless steel.

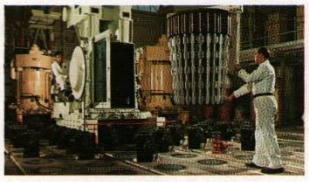
Nuclear Fuel



The fuel currently being used in the first generation of nuclear reactors consists of natural uranium metal clad in a magnesium-aluminium alloy having a very high corrosion resistance. This form of cladding is known as MAGNOX and its name is used to describe the family of reactors using this type of fuel.

To improve the steam cycle efficiency of the second generation of reactors — the so-called Advanced Gas Cooled types (AGR's) — and to extend the burn-up time of the fuel, they were designed to operate with higher coolant pressures and at much higher temperatures (typically 600°C). To meet these requirements a different type of fuel in the form of ceramic pellets of uranium dioxide (UO_2) clad in stainless steel has been developed. The result has been an increase in steam cycle efficiencies from about 30% to more than 40% and with burn-up times expected to exceed 18,000 MWd/Te (megawatt-days per tonne).

A basket of fuel elements being loaded into a Calder Hall charge machine. ▼



Work is continuing at Harwell into problems associated with corrosion, oxidation and swelling of fuels so that their useful life within the reactor can be extended still further.

Nuclear Waste

The highly radioactive waste products arising from nuclear power stations are at present stored in liquid form in water-cooled tanks at the Windscale reprocessing plant.

To improve the safety of storage and ease the problems of subsequent disposal, research is being undertaken at Harwell and elsewhere throughout the world into possible methods of incorporating the waste as a solid homogeneous mixture, in insoluble glass blocks clad in thick stainless steel jackets. The blocks would typically be of cylindrical form and weigh in the region of 1 tonne, of which about 25% would be radioactive waste.

The work being done at Harwell is known as the HARVEST project, an acronym derived from Hazardous Radioactive Waste Vitrification Engineering Study.