SELLAFIELD

INTRODUCTION

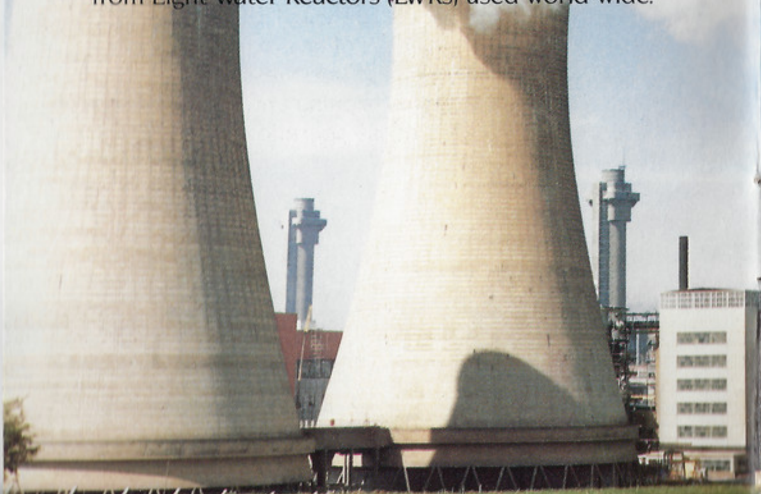
Sellafield has been involved since 1952 in reprocessing irradiated (or spent) nuclear fuel, establishing itself as a world leader in this high technology field.

What is reprocessing? Basically, it involves a series of chemical separation processes in which uranium fuel rods which have been used to produce electricity in a nuclear reactor for a number of years are treated to separate residual uranium (at least 96% by weight of the total) and the by-product plutonium (about one per cent of the total). It also enables highly-active waste (less than three per cent of the total) to be separated, for safe storage.

The reclaimed material can be used again as fuel and this increases the energy potential of the uranium fuel rod by 30 to 40 per cent. If the uranium and plutonium were used to their fullest potential by continuous recycling in fast breeder reactors, the energy potential of the fuel rod would be increased by about 50 to 60 times.

The present reprocessing plant at Sellafield came on stream in 1964, replacing one operating since 1952 and is designed primarily to reprocess fuel from Magnox reactors – the UK's first generation of nuclear power stations. This fuel consists of natural uranium fuel rods contained in a magnesium alloy (Magnox) can.

A new plant to reprocess fuel from modern nuclear power stations in this country and overseas is being built at Sellafield. The Thermal Oxide Reprocessing Plant (THORP) will handle Advanced Gas-cooled Reactor (AGR) oxide fuel pins – uranium dioxide pellets in stainless steel tubes – as well as other oxide fuel from Light Water Reactors (LWRs) used world-wide.



ORGANISATION

Above Chemical reprocessing plant, part of the Windscale Works.
Below Calder Hall nuclear electricity generating station.

The Sellafield site is divided into two works comprising the major operating units, with a central site support organisation.

Windscale Works includes the chemical reprocessing plants, effluent disposal and facilities for plutonium fuel fabrication and waste management, research and development, technical accountancy and site training.

Calder Works includes the Calder Hall power station and a similar station at Chapelcross in Dumfriesshire, fuel receipt, storage and decanning plants and site engineering services.

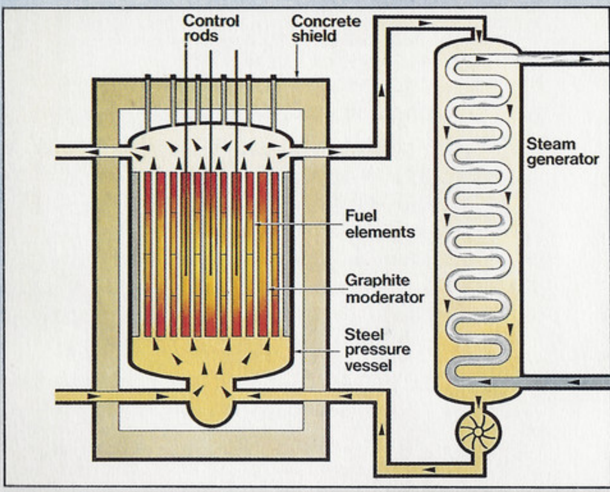
British Nuclear Fuels plc is licensed to operate the Sellafield site by the Health and Safety Executive (HSE) under the terms of the Nuclear Installations Act 1965, revised 1982. Under the terms of the licence, the Nuclear Installations Inspectorate (NII) – part of the HSE – is closely involved in the design, building, commissioning and operation of any plant which may affect safety. The NII carry out safety assessments before construction, commissioning and operations begin and also during process operations.

MAGNOX REPROCESSING

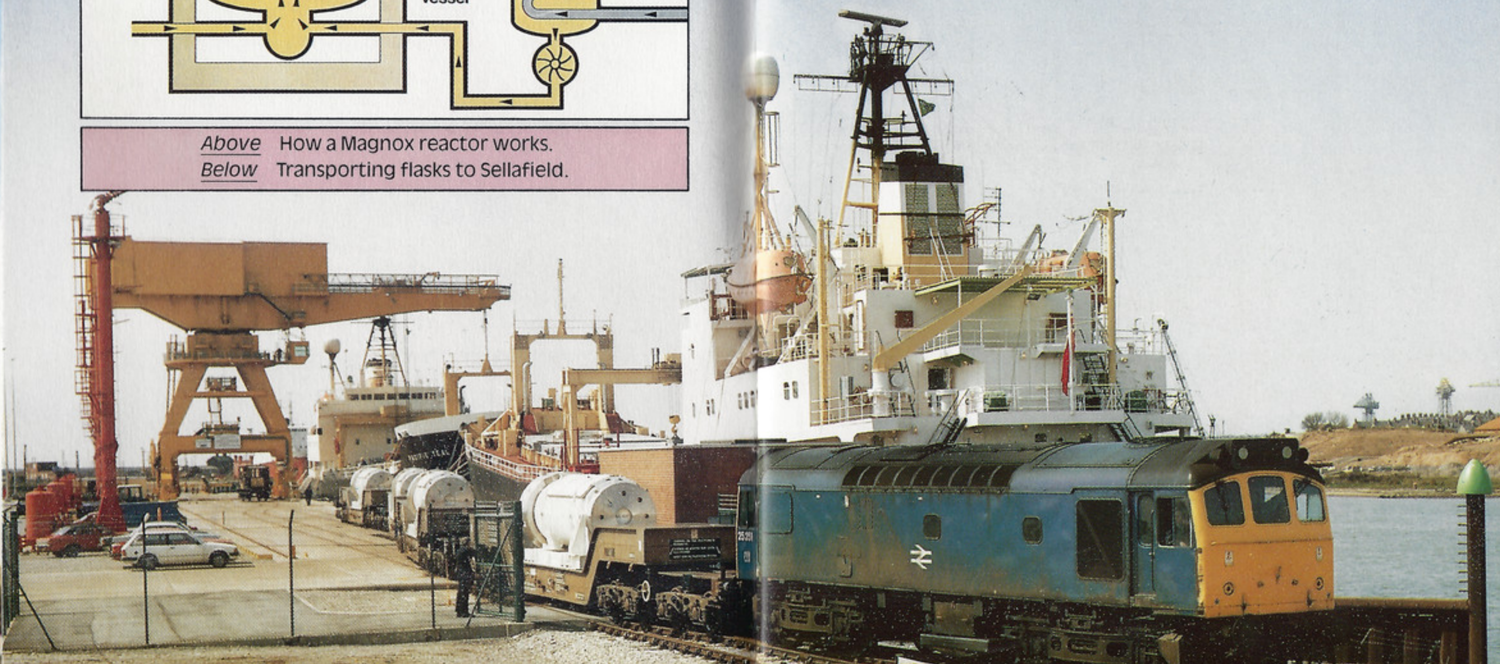
USING NUCLEAR FUEL IN A REACTOR

Electricity is generated by turbo-generators driven by steam, which is produced by heating water. In a nuclear power station the source of the heat is the fission, or splitting, of uranium atoms in a reactor.

Nuclear fuel remains in the reactor for several years, but has to be replaced eventually. On removal from the reactor the spent fuel is stored in cooling ponds at the power station for a minimum of 90 days to allow some of the radioactivity to "die away". The fuel is then sent to Sellafield for reprocessing to separate uranium and plutonium and to remove the waste products.



Above How a Magnox reactor works.
Below Transporting flasks to Sellafield.



TRANSPORT OF FUEL

Spent fuel has been transported safely to Sellafield for reprocessing from nuclear power stations within the UK, Europe and the Far East for over 20 years. In that time there have been over 7,000 flask journeys in the UK and overseas.

Flasks for the transport of spent fuel are constructed of extremely strong containers made of steel or steel and lead. These flasks are designed and tested to stringent international standards to withstand a severe transport accident without the release of dangerous amounts of radioactivity.

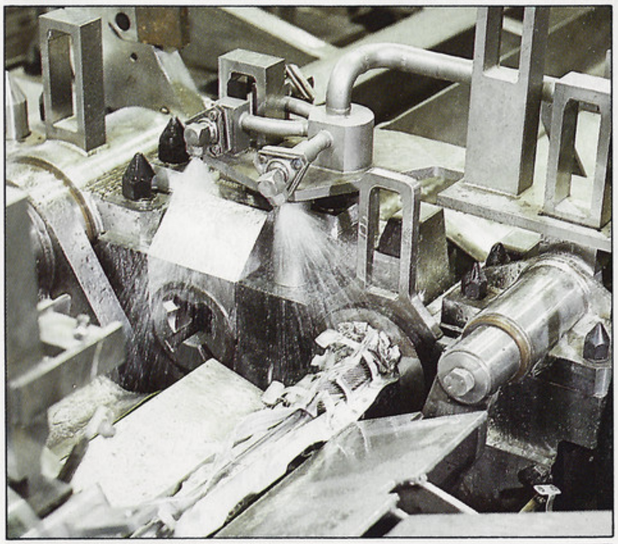
USED FUEL STORED IN PONDS

On arrival at Sellafield the fuel elements are transferred from the transport flasks into containers which are stored under water in cooling ponds to await reprocessing. The spent fuel is still highly radioactive and continues to generate heat. The water provides the required degree of cooling to absorb heat and shields the operators from radiation emitted by the fuel. Storing the fuel enables short-lived radioactivity to die away before the fuel is reprocessed.

Above Fuel storage pond.
Left Handling of a fuel transport flask at Sellafield.

DECANNING OF MAGNOX FUEL

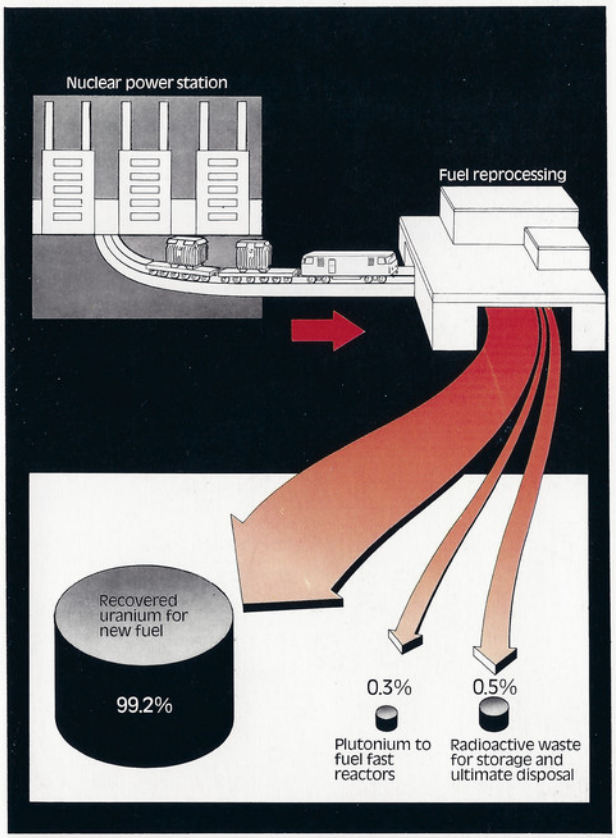
The magnesium alloy cladding around the Magnox fuel element must be removed so that the used uranium fuel rod inside can be reprocessed. Decanning is carried out using remotely-controlled equipment in thick-walled cells to absorb the radioactivity from the used fuel. The cladding material remaining after the decanning operation is transferred to shielded storage silos, where it is stored under water.



Above Remote decanning operations.
Below Decanning of Magnox fuel.

SEPARATION PROCESS

After decanning, the uranium fuel rods are transferred to the reprocessing plant. They are fed into a dissolver where they are continuously dissolved in nitric acid. Waste products are removed from the solution by a chemical separation process and later the remaining uranium and plutonium are similarly separated. The uranium is either returned to the customer, stored, or sent to the Company's Springfields Works near Preston for re-use in the fuel cycle. The plutonium is either fabricated into fuel at Sellafield for use in the United Kingdom Atomic Energy Authority's Prototype Fast Breeder Reactor at Dounreay in Scotland, stored for eventual use, or returned to the customer under international safeguards arrangements.



Reprocessing of irradiated Magnox fuel.

HIGHLY-ACTIVE STORAGE TANKS

During reprocessing, highly-radioactive waste is separated from the fuel and then concentrated for storage. This concentrated waste is at present stored in liquid form in high-integrity stainless steel tanks, double-clad and located in concrete vaults, which are themselves clad in stainless steel. In the past 30 years some 1,200 cubic metres of highly-active waste has been produced and safely stored at Sellafield.

A highly-active waste tank under construction.

VITRIFICATION

Storage of highly-active liquid waste in tanks has been demonstrated as safe and reliable, but it is expensive on capital investment and operating costs and it is now internationally accepted that it is better to convert the wastes into a solid form for more convenient storage and eventual disposal.

A plant for the conversion of the waste to a solid glass-like form (vitrification) is being installed at Sellafield and will be operational in a few years.

The vitrification process involves mixing the highly-active waste with glass-making materials to form glass blocks, enclosed in metal containers. These will be stored for several decades before ultimate storage.

This glass disc simulates the amount of vitrified waste produced by one person in a lifetime if all his electricity was produced by nuclear energy.

WASTE DISPOSAL

All industrial processes produce waste in a variety of physical and chemical forms, each of which needs special consideration. So it is with the nuclear industry. There are only two acceptable ways of dealing with radioactive wastes of any kind if they cannot be destroyed or are not worth recycling. They may either be disposed of to the environment as they are produced, or stored for some of the radioactivity to die away before disposal to the environment.

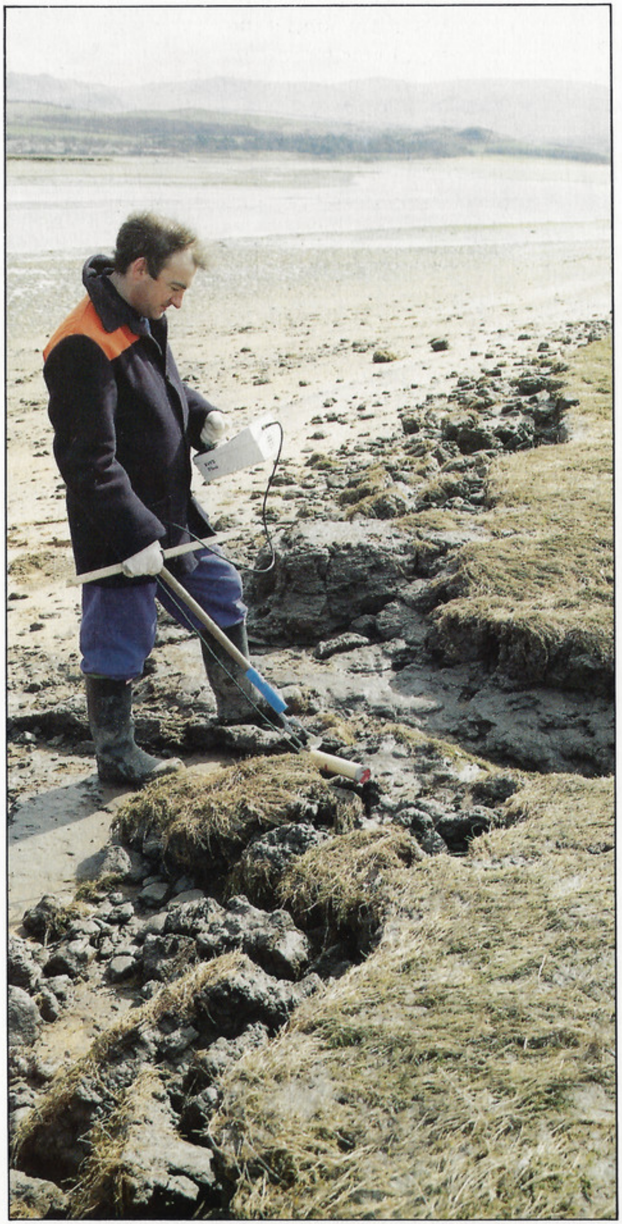
Over 99 per cent of the radioactivity in waste arising from the reprocessing of fuel at Sellafield is currently stored on site.

Low-active liquid waste is discharged into the Irish Sea through a pipeline which extends one and a half miles from shore. Low-active solid waste such as contaminated apparatus, containers and clothing is buried in trenches at the Drigg disposal site near Sellafield.

Discharge of these wastes is carried out under authorisations set by the Department of the Environment and Ministry of Agriculture, Fisheries and Food. Both British Nuclear Fuels and the relevant Government Departments carry out monitoring programmes to assess the environmental effects of the discharges and to confirm that radiation doses to the public are within the dose limits recommended by the International Commission for Radiological Protection (ICRP).

The quantity of radioactive material discharged to the Irish Sea has been steadily reduced over recent years. Long-lived alpha discharges have already been cut to one-thirtieth and shorter-lived beta radiation emitters to one-fifteenth of peak levels of the mid 1970s. New plant scheduled to be brought into operation by the early 1990s will progressively reduce total liquid discharges from Sellafield, notably the alpha emitters, to a target less than 1% of peak levels. Beta discharges will also be reduced, to a few per cent of peak levels.

Wastes which do not generate heat in significant amounts but which cannot be disposed of to sea or buried at Drigg are classified as intermediate level wastes (ILW). They are currently stored in special facilities at Sellafield. BNFL plans to encapsulate these wastes in a cement-based matrix in preparation for ultimate disposal. The first encapsulation plant, construction of which has started, is planned for operation by 1989. Some storage capacity for the encapsulated product will be provided at Sellafield, pending the availability of an appropriate disposal route. The disposal of the encapsulated product is the responsibility of the UK Nuclear Industry Radioactive Waste Executive Ltd.



Monitoring radiation levels near Sellafield.

HEALTH AND SAFETY

Throughout industry as a whole, it is essential to set standards of protection to safeguard both workers and the general public.

At Sellafield there are specialist departments dedicated to both conventional and radiological safety and medical services, equipped with modern facilities for monitoring the health of workers. This includes keeping extensive medical records of everyone who has worked at Sellafield, including details of exposure to radiation.

Employees are protected by a combination of safe working procedures, plant design, safeguards such as adequate radiation shielding (enclosing plant in concrete cells or boxes lined with stainless steel or lead), the use of remote handling equipment where necessary and extensive ventilation systems.

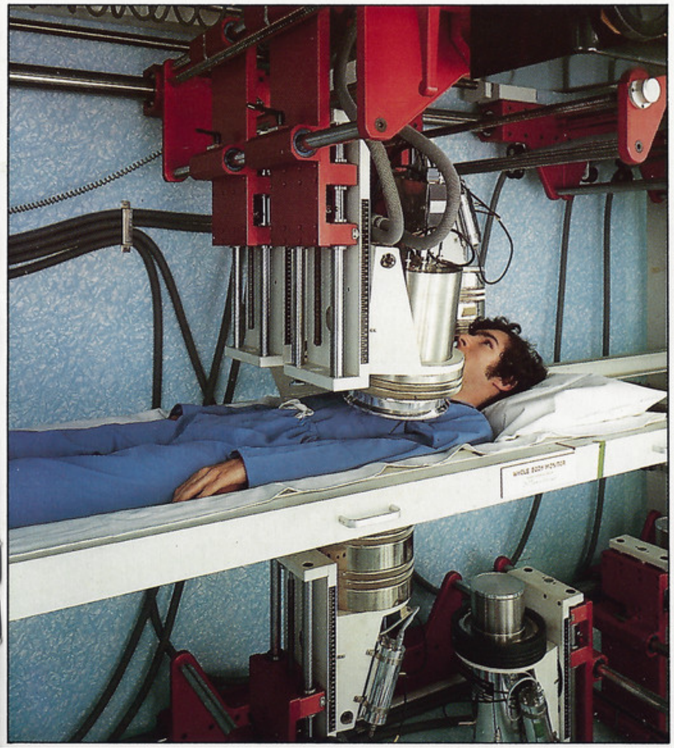
Their working environment is continuously monitored and surfaces systematically checked for radioactive contamination. In addition, special monitoring equipment checks the site for airborne contamination and regular checks are made on the environment in and around the site.

For employees working in the radioactive processing area, special protective clothing is provided before entry via the changerooms. On leaving the process area employees remove this clothing and, after washing, follow a radiation monitoring procedure.

Dosemeter badges that assess external radiation doses are the most widely used of the monitoring instruments and are issued to employees and everyone visiting the radioactive processing area.

Occasionally some employees undergo tests to detect any radioactive materials which may have entered the body. In some cases regular checks are carried out using the whole body monitor – a sensitive piece of equipment used to detect radiation given off by small amounts of radioactive substances in body tissues.

Facilities for using the whole body monitor have been offered to members of the public living in the Sellafield area.



Above Changeroom.
Below Haematology section of the medical department.

Whole body monitor.

CALDER HALL

Calder Hall is best known as the world's first industrial scale nuclear electricity generating station and as such paved the way for the whole UK nuclear energy programme. It has been operating since October 1956 and is expected to operate into the 1990s.

The station uses Magnox fuel and in each of the four reactors, more than 10,000 fuel elements are stacked in channels, five or six fuel elements per channel. As the uranium atoms fission, or split, the fuel in the reactor gets hot. The heat is removed by carbon dioxide gas that flows over the hot fuel transferring the heat from the core of the reactors to the boilers, where the heat converts water to steam which is used to drive turbo-generators to produce electricity.

Nuclear power stations have a first class safety record. The experience with Magnox stations in Britain is now equivalent to over 600 reactor years of operation.

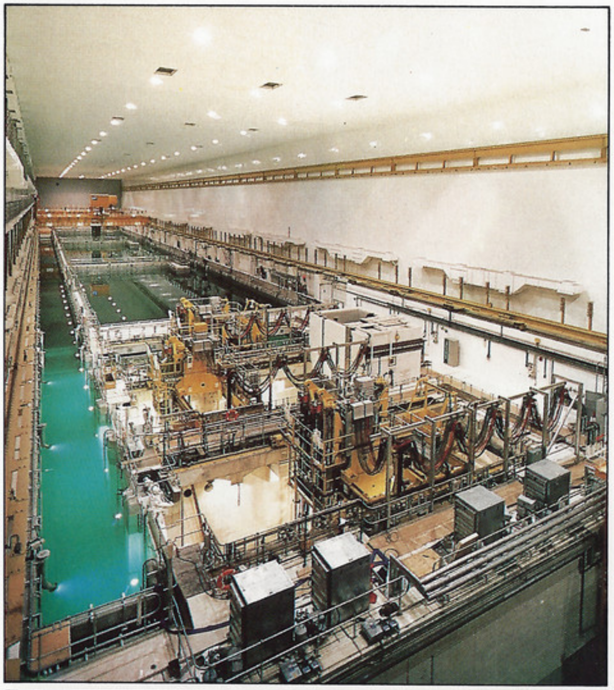
There are now nine commercial nuclear power stations based on the Calder Hall design operating in the UK, each with two reactors. They have been successful and reliable in operation and, together with the second generation of nuclear power stations in Britain, the Advanced Gas-Cooled Reactors, now produce some 20% of our electricity.

Discharging spent fuel at Calder Hall.

FUEL HANDLING PLANT AND SIXEP

The Fuel Handling Plant, a new plant for the receipt, storage and decanning of Magnox fuel, was commissioned in 1985, and is primarily intended to increase the storage capacity and throughput of spent Magnox fuel for reprocessing. There is also provision for the receipt, storage and dismantling of AGR fuel. Emphasis has been given in the design of the plant to the control of fuel corrosion and the plant also incorporates improved methods of decontamination and remotely maintaining equipment.

The Site Ion Exchange Effluent Plant (SIXEP) which has been built to reduce discharges of low level radioactivity to the Irish Sea commenced operation in 1985. The plant is designed to treat water from the various fuel storage ponds by use of an ion exchange process to reduce the discharge of beta emitters (mainly caesium and strontium). The plant also provides a cooling service for the water from the Fuel Handling Plant next door. Up to about 11,000 cubic metres of pond water per day can be recirculated in this way.



Main storage pond hall in the Fuel Handling Plant.

Sea discharge treatment cell vessels and pipework in SIXEP.

FUTURE DEVELOPMENTS

A major capital investment programme is underway at Sellafield involving expenditure of some £2,500 million on the refurbishment or replacement of existing reprocessing facilities for fuel from Magnox power stations, waste management programmes and the provision of facilities for the storage and reprocessing of spent oxide fuel from the UK nuclear programme and from overseas reactors.

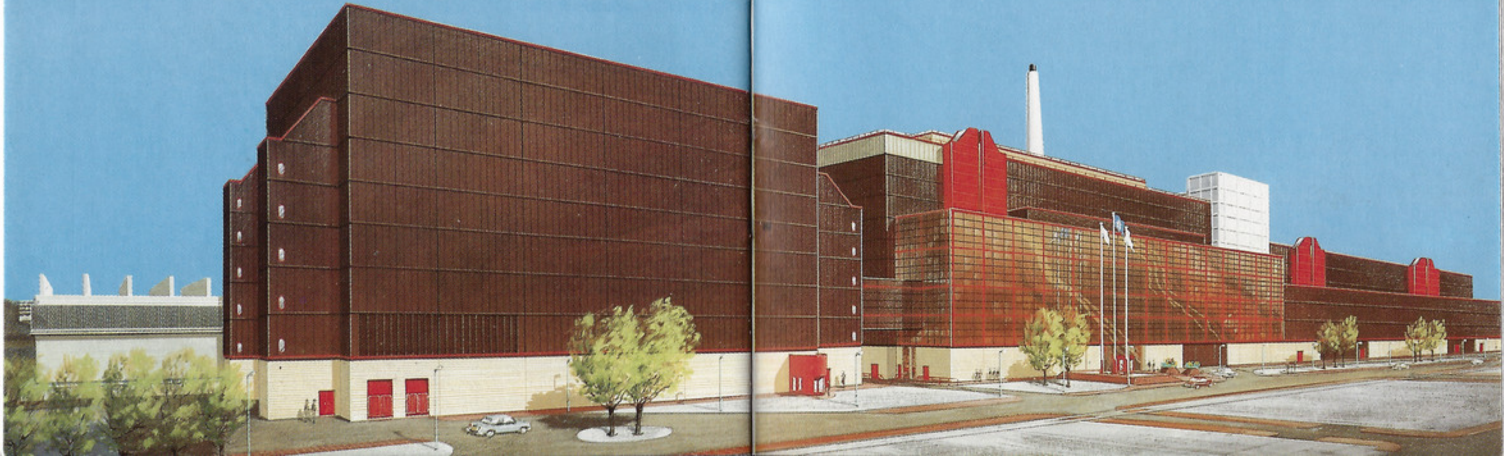
The programme is aimed not only at maintaining the site's position at the forefront of reprocessing technology but at ensuring future success in world markets.

The biggest project being undertaken is the £1,350 million Thermal Oxide Reprocessing Plant (THORP). This plant is designed to reprocess irradiated oxide fuel from the UK's Advanced Gas-cooled Reactors and from Light Water Reactors. It is planned to be operational by the early 1990s and is expected to deal with 6,000 tonnes of irradiated fuel over its first ten years of operation. Plant necessary to support the THORP operation will cost a further £300 million. Research and development work at Sellafield includes a miniature pilot plant for THORP which covers all parts of the production process and various full-scale test rigs.

More than £500 million is being spent on waste management at Sellafield. Work is proceeding on plants to encapsulate intermediate level solid wastes such as cladding material stripped from Magnox elements before reprocessing, sludges from storage ponds, spent ion exchange material from SIXEP and solid waste from THORP. The wastes will be encapsulated in a cement-based matrix in stainless steel drums which will then be stored pending the availability of a disposal route.

Above THORP miniature pilot plant.

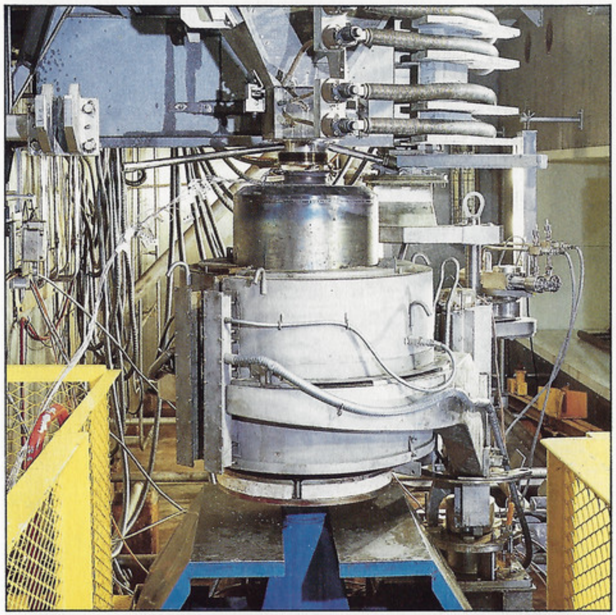
Below Artists' impression of Thermal Oxide Reprocessing Plant.



A vitrification plant to convert the highly-active liquid waste from reprocessing to a solid glass form is also under construction at Sellafield. The process is being tested under plant conditions in a full scale inactive vitrification plant including identical mechanical components to the final plant.

Plants are also under construction for the receipt, sorting and preparation for storage or disposal of plutonium contaminated material. This material includes redundant items of plant and equipment, gloves used in glove boxes, filters, cleaning materials, swabs and safety clothing.

As part of the commitment to reduce such discharges to very low levels plans have been announced for a major project to provide substantial additional effluent treatment and storage plant at Sellafield. Each stage of this project will be introduced progressively with corresponding reductions in discharges.



Vitrification pilot plant.

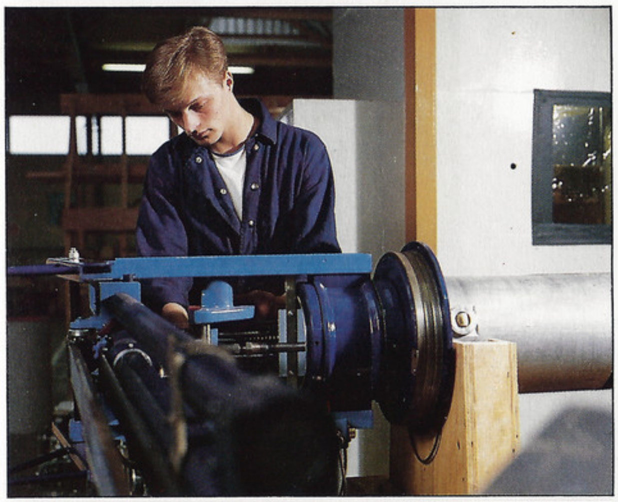
TRAINING YOUNG PEOPLE

At present, about 500 craft apprentices and junior process workers are being trained at Sellafield in a purpose-built training centre, where facilities include engineering workshops, laboratories, lecture rooms, library and gymnasium.

In addition to the main engineering trades of fitters, instrument mechanics and electricians, the centre also provides training facilities for joiners, fabricators, welders, motor mechanics, painters and plumbers. The standard of training facilities provided and the high level of recruitment indicate the importance the Company attaches to the training of young people.

The trainees study at local colleges for appropriate Technician Education Council and City and Guilds qualifications during their one to four-year course and some go on to degree courses at universities and polytechnics.

Apprentices attend Outward Bound Courses and activities outside their normal training programme are encouraged, such as community service and the Duke of Edinburgh Award schemes. The centre's outstanding contribution to this latter scheme led to it becoming an Operating Authority, able to organise its own training, assess participants and authorise awards. Other schemes include City Challenge, which comprises projects to help the sick, elderly and handicapped, and courses organised by the Police and other organisations.



Second year apprentice fitter working on a master slave manipulator.

COMMUNITY RELATIONS

With the decline of the traditional industries such as coal mining and steel making, Sellafield has become a major employer in West Cumbria.

About 10,000 people currently work at the site, of whom more than 6,000 are employees of British Nuclear Fuels, about 500 work for the United Kingdom Atomic Energy Authority and some 3,000 are employed by contractors on various construction projects. Every effort is made to recruit from the works catchment area, local people at present accounting for some 80-85 per cent of the Company's workforce.

The Company involves itself in numerous projects in West Cumbria, helping to finance local road construction and various council projects. Its considerable contribution to the renovation of Whitehaven's town centre, with its Georgian properties of outstanding architectural quality, resulted in the Company receiving a Civic Trust award.

Apprentices are encouraged to become involved in local community service, taking part in projects to aid organisations, particularly those involved with the handicapped and elderly.

A charity lottery fund run by employees provides some £50,000 of equipment a year to deserving groups, with a total value of equipment donated of more than £350,000, and an annual sporting event

The permanent exhibition centre.

organised by employees – the Windscale Marathon – raises thousands of pounds each year for the local hospital.

In addition to services for Sellafield personnel and local general practitioners, the site medical department offers a unique service to West Cumbria in genetics and in the use of radio-isotopes in the diagnosis of disease.

The site's Information Services department also provides a vital link with the local community and further afield by organising visits to the site, including the permanent Sellafield Exhibition Centre, for over 50,000 people a year. The exhibition, open seven days a week, includes computer games, working models and video presentations, as well as cinema and seminar facilities.

The Company's positive attitude towards informing the public on its operations is enhanced by the Speakers' Panel, through which employees give talks on nuclear energy to numerous organisations. This provides an opportunity for open and frank discussion on many vital topics affecting the industry.

There is further opportunity for public involvement in the Company's operations, development plans and future aims through the Sellafield Local Liaison Committee. Local elected representatives and officials from the county, district and parish councils take part in this committee, which also comprises management representatives, government departments involved in the industry, members of the National Farmers' Union and area health officials. All aspects of Sellafield's operations and Company policy are discussed at the regular meetings of this committee, which are open to the press and public.

Restoration of Georgian buildings, Whitehaven.

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