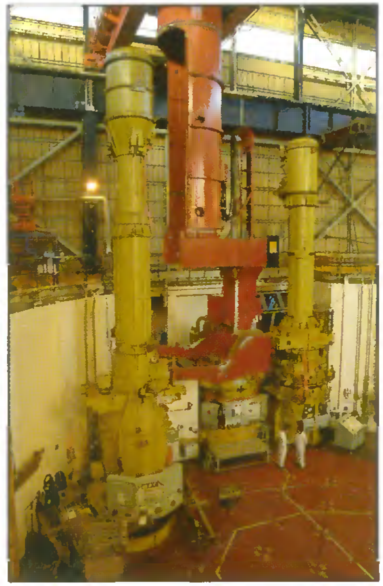
BERKELEY



POWER STATION

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WELCOME

Each year we are delighted to receive an increasing number of visitors to Berkeley Power Station – from different parts of the country and from many different walks of life. We hope that you enjoy your visit to our Power Station, and that through viewing each stage of the production process you will gain an appreciation of the role of the Central Electricity Generating Board – and the important part that nuclear produced electricity plays in the co-ordinated provision of the electrical energy that is fundamental to our national well being.

BERKELEY

The town of Berkeley and its surrounding area are rich in history, some of which is substantiated, the rest a matter of conjecture or tradition. Some say that William Shakespeare lived, if only for a short time at Dursley only a few miles to the east; others say that somewhere, closer still is the site of the battle of Camlann where King Arthur fought his nephew Sir Mordred and died. Less tenuous is the claim that William Tyndale, the man responsible for the first printing in English of the bible was born at Slimbridge. Better documented still is the fact that George Thorpe of Wanswell Court led a party to the New World. Virginians claim that this party from Gloucestershire held the first Thanksgiving at the Berkeley Plantation and Hundred in December 1619, more than a year before the Mayflower dropped anchor. The proudest boast is that Berkeley was the birthplace and home of Edward Jenner, the *father of immunology*. But the most tragic and savage event was the murder of King Edward II in Berkeley Castle.

Keep and inner court entrance from the garden.

The Castle is the Gloucestershire home of Mr and Mrs R J Berkeley; it has been in the family since the middle of the 12th century.

The *great castle,* described as a *jumble of massive walls, stout buttresses, towers and tall chimneys* is built of local red sandstone. It is likely that the original castle was a wooden stockade which was replaced by a Norman Keep (or defensive tower). Maurice Fitzhardinge, the First Lord Berkeley, added the gatehouse and the deep ditch or moat that separated the castle from the town.

The present Great Hall was built in 1340 by the Third Earl of Berkeley. It was built on the site of the original which is said to have been where the West Country Barons assembled before travelling to meet King John to sign the Magna Carta at Runnymede.

In 1470 a dispute between William Lord Berkeley and Thomas Viscount Lisle resulted in the latter's death at what is reputed to have been the last private battle in England.

On 21st September 1327 King Edward II was murdered at the castle; his body remained there for a month, having been refused burial by the monks at Bristol, Kingswood and Malmesbury. It was then taken by John Thokey, Abbot of Gloucester to the Abbey of St. Peter where it was *honourably received by the whole community with all the City in procession.*

The Castle is open to the public from Spring to the early Autumn.

The Long Drawing room.

Small Drawing room.

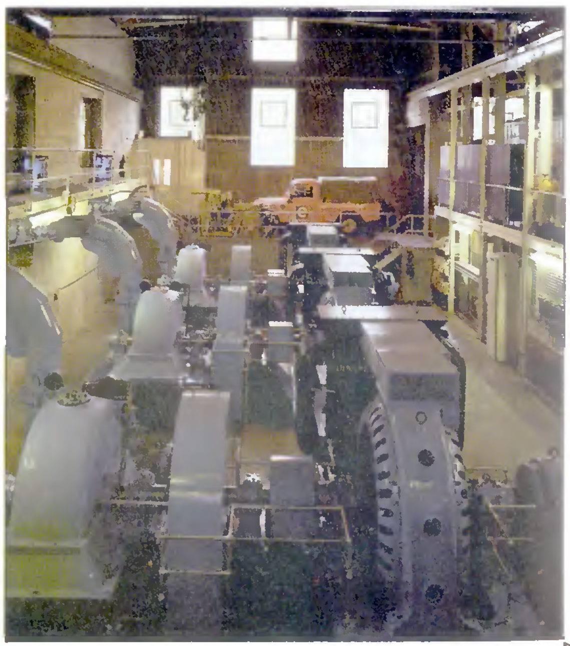
The Central Electricity Generating Board is responsible for producing electrical energy to satisfy the needs of the whole population of England and Wales. The Board has a statutory duty to develop and maintain an efficient and co-ordinated economic system of electrical supply to the consumer, which it carries out through the National Supergrid transmission network.

There is a steadily increasing demand in electricity due not only to modern industrial methods which call for more electrically driven machinery, but also to rising standards of living reflected in the domestic consumer's increasing use of electrical power. It is estimated that this increasing demand will require up to 8 or 9 new power stations to be built by the turn of the century.

As electricity cannot be stored, and there is the expectation that power will be available at the instant an appliance is switched on, sufficient generating capacity must be available to meet the whole of the possible demand at any given time. This presents the generating industry with particular planning problems and requires a great flexibility of reponses to the changing patterns of demand – both on a daily and seasonal scale. A further important consideration that CEGB planners have to take into account is that certain power stations (notably nuclear stations) generate electricity considerably more cheaply that others.

Power from Coal: The coal stockyard at Drax power station in Yorkshire.

Hydro-electric power: The Turbine hall of the tiny Mary Tavy power station.



CEGB

NATIONAL GRID

Electrical energy is generated in 78 power stations, and is transmitted through 400 kV and 275 kV lines and cables through the National Supergrid. These circuits are linked together by transforming stations to the distribution networks of the Area Electricity Boards who are the Board's customers.

Europe's first airborne power-line repairs. A 275kv line spanning the river Usk at Newport South Wales was repaired through the use of a cradle suspended from a powerful helicopter. The CEGB saved £250,000 over conventional repairs – and the work was completed in 45 minutes rather than several weeks.

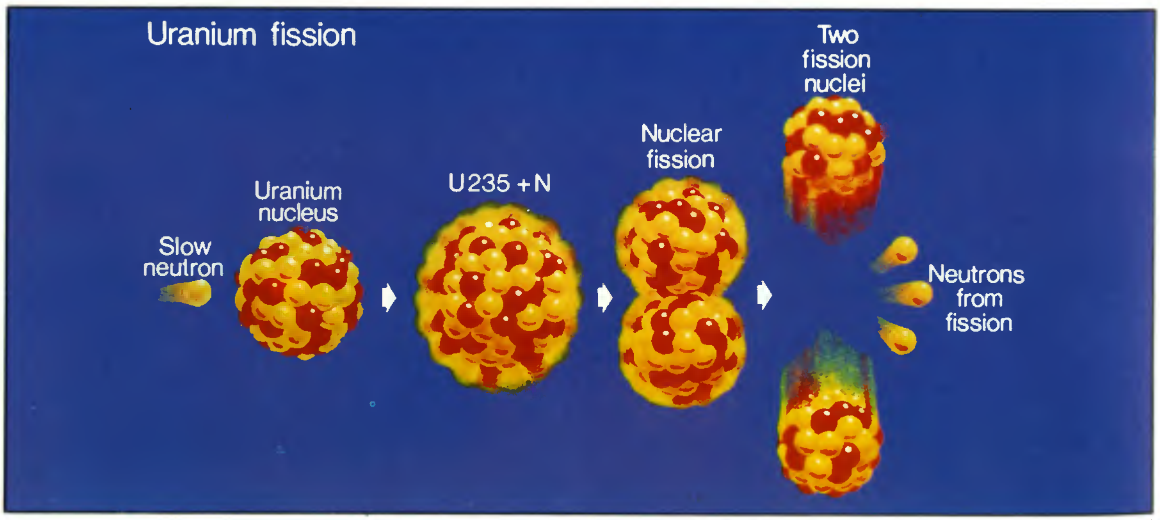
THE NATIONAL SUPERGRID AND NUCLEAR POWER STATIONS IN ENGLAND AND WALES

NUCLEAR FISSION

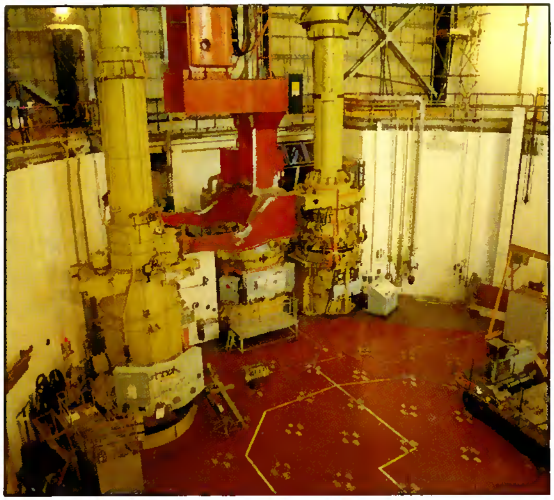
Atoms are very small – in fact they are so tiny that 10 million might just stretch across a full stop on this page. Small though they are, atoms are composed of three smaller fundamental particles – PROTONS and NEUTRONS (which together form the NUCLEUS) and ELECTRONS which orbit the nucleus. All substances have different sorts of atoms and this difference comes from them having different numbers of protons. There are 92 different naturally occurring atoms such as hydrogen, carbon, iron, uranium. They form the chemical elements, of which an atom is the smallest identifiable part. Elements combine to form compounds. For example, hydrogen and oxygen combine to form water, sodium and chlorine produce salt, and the burning of coal combines carbon with oxygen. Such chemical reactions sometimes produce energy as in the burning of coal in a conventional power station. Alternatively, if the nucleus itself is broken up, then some of the energy of the large forces binding the protons and neutrons together in the nucleus is released. This process is known as NUCLEAR FISSION (commonly called splitting the atom). At Berkeley Power Station, for each unit of fuel used the amount of energy released by nuclear reaction is 10,000 times greater than the amount that would be released by a chemical reaction.

To achieve fission, a neutron is made to collide with the nucleus of a uranium atom which causes it to break up and release some free neutrons. These neutrons are then made to collide with more nuclei so producing more free neutrons. This CHAIN REACTION provides the basis of a power producing system. But a fission chain reaction will only occur under certain conditions, the most important of which is that the neutrons will not cause fission unless they are slowed down or MODERATED. At Berkeley this is achieved by using 3,000 tonnes of graphite in each reactor. The graphite – which is similar to that used in a pencil – is known as the MODERATOR.

URANIUM is one of the few natural materials whose atoms will sustain a fission chain reaction easily. There are two main forms of natural uranium atoms (called isotopes) which are known as Uranium 235 and Uranium 238. These forms are chemically identical, having the same number of electrons and protons, but U238 has three extra neutrons in the nucleus. Over 99% of natural uranium is U238 and less than one per cent U235. Fission of the U235 atoms takes place inside one of two REACTORS which are housed in separate buildings at Berkeley.



The actual rate of nuclear fission is controlled by increasing or decreasing the number of free neutrons. If the chain reaction is to be reduced or stopped, it can be done rapidly by releasing boron steel rods into the reactor. These rods, known as CONTROL RODS absorb some of the free neutrons, so reducing the fission process. When the control rods are raised, there is less neutron absorption, and so fission increases. Even at full power there are always some rods partially in the reactor, thus ensuring that there is always complete control of the fission process.



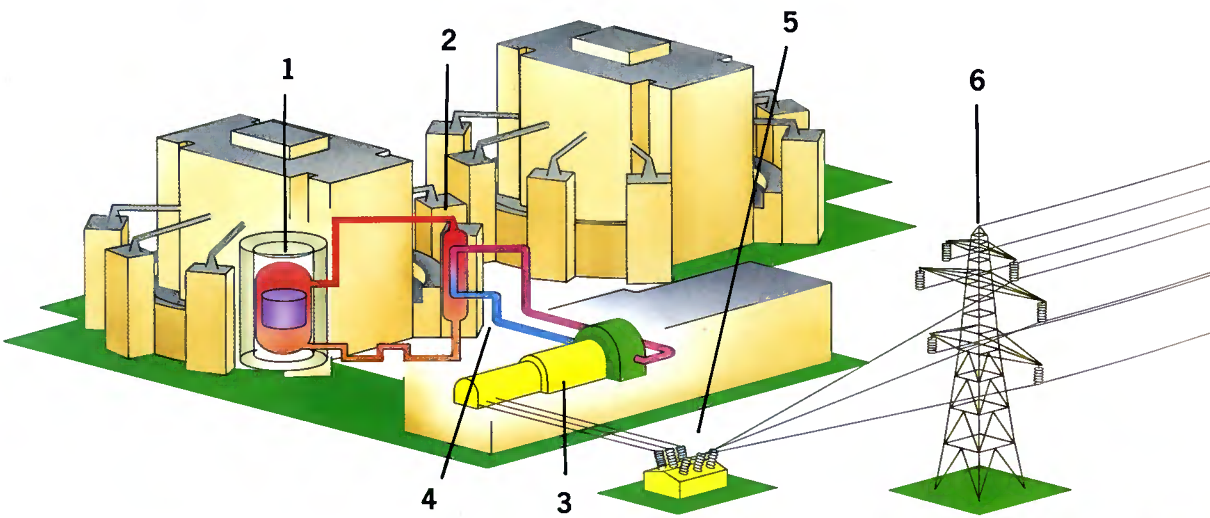
The pile cap floor, showing machinery used for re-charging the reactor. The machine on the left may be used to remove the control rods from the reactor core.

ENERGY FROM BERKELEY

Electrical energy generated from nuclear power stations now accounts for over 16% of all CEGB production. As our need for electrical energy is expanding every year, and our resources of the fossil fuels – gas, coal and oil – is diminishing, it follows that the cost of these fuels will inevitably rise. Nuclear energy provides an alternative to depleting our finite stocks of fossil fuels whilst at the same time producing cheaper electricity. Sir Frank Layfield's report on the Sizewell Pressurised Water Reactor concluded that there was an economic justification for the further development of nuclear power.

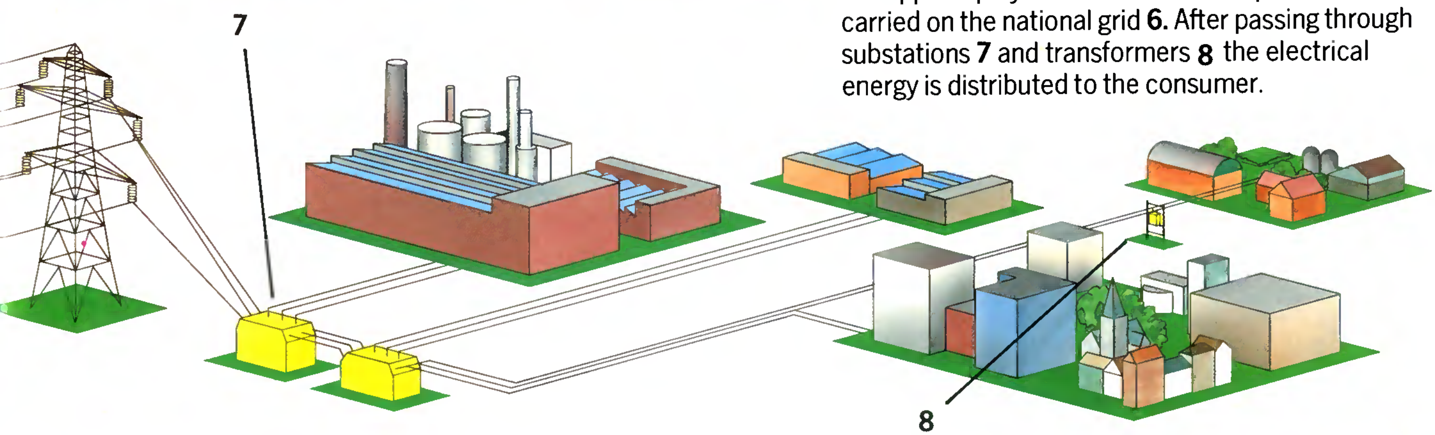
All power stations produce electrical energy in a similar way. Electricity is generated by spinning a long shaft – the rotor – which is an enormous magnet. Thick copper coils are placed all around the outside of the rotor to form the stator, and as the shaft is made to rotate, electricity is generated in the copper bars of the stator.

The energy needed to make the generator rotor spin is obtained from steam that has been produced by heating water. The steam, under very high pressure, is directed against rows of huge rotating blades inside a turbine, causing the rotor to spin at high speed. At Berkeley, the heat energy is obtained from nuclear fission.



The fission produced heat is harnessed from the fuel by carbon dioxide gas pumped through the reactor. In absorbing the heat, the temperature of the gas increases from 160 to 354 degrees celsius. The gas passes from the reactor and into the 8 boilers that serve each reactor. Here the gas comes into contact with the water pipes (though not the water itself). The demineralised water is boiled, thus turning it into dry superheated steam. Steam is carried in pipes from the boiler into the Turbine Hall, where it strikes the turbine blades making them spin at 3,000 revolutions per minute, thus driving the generator to produce electricity. The steam, now cooled back into a liquid form known as condensate, is re-used by being circulated back to collect more heat from the reactor gas.

The fission-produced heat raises the temperature of the gas pumped through the core **1.** The gas is carried to the boilers **2** where its heat is transferred to the water, turning it into steam which drives the turbo-generators **3.** The steam now condensed back to water is recycled **4.** The voltage produced is stepped up by a transformer **5** and power is carried on the national grid **6.** After passing through substations **7** and transformers **8** the electrical energy is distributed to the consumer.



THE RIVER SEVERN

The River Severn is important to Berkeley Power Station as up to 95,000,000 litres of water is used each hour for cooling steam back into water in the turbine house. The river is over a mile wide at this point and is strongly tidal and for a continuous supply, the cooling water must be taken from the deep shipping channel which is beyond a baffle wall. Two concrete tunnels, each 3 metres wide, extract the cooling water at a depth of 30 metres thereby ensuring a constant supply at any tidal level of the river. The river water passes through a filtering screen to remove debris, and is then pumped into one of the two forebays.

The baffle wall ensures that cooling water taken from the river is not affected by the returning flow.

The Severn is over 1 mile wide at this point.

River debris is removed from the cooling water before use.

The cooling water pump house.

COOLING WATER

Although there are six pumps in the cooling water pump house, when the station is operating at full power only four of the 900 h.p. units are required to pump cooling water into the turbine hall. The pumps, which are contained in two separate sections in order to maintain supplies in case of a burst or flooding, can be isolated on the inlet and outlet side in order to allow maintenance to be carried out.

Each of the four turbo-generators has three condensers. These allow the used steam to be turned back into water (the condensate) in order for it to be pumped back to the boilers for re-use. Both the cooling water and the de-mineralised water used to drive the turbines operate in separate closed systems. The systems are kept separate as the water which passes through the boilers and turbines has to be pure in order to ensure efficient running of the plant. Ordinary mains water is used which has to be purified further by special treatments. The river water cools the steam to condensate, and in so doing its temperature increases by up to 8 degrees celsius and it is then pumped immediately back into the river some distance away from the intake point, on the station side of the baffle wall.

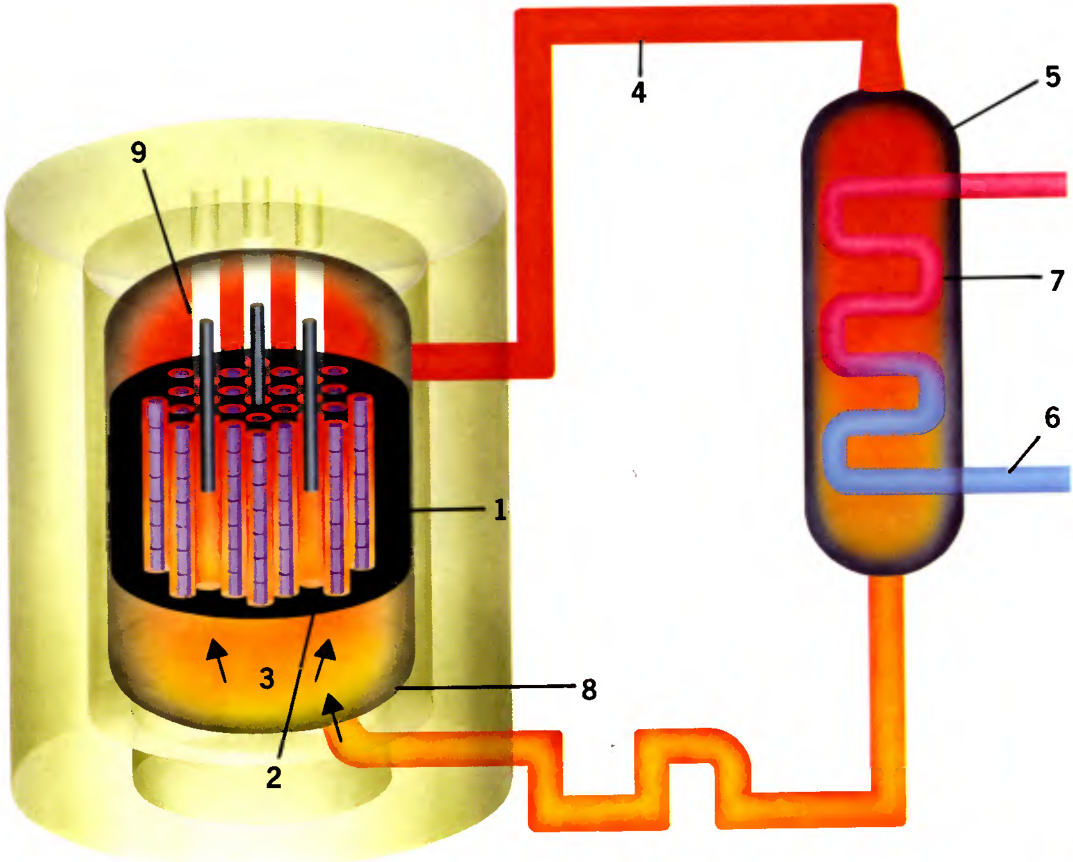
Three condensers are sited under each turbo/generator.

The Severn has the world's second greatest tidal range.

REACTORS

The two ractors are identical. The cores **1** are built from graphite bricks one metre in length and 20cm in width. They are interlocked in such a way as to provide 3,265 channels **2** running down the length of the core into each of which 13 uranium fuel elements are placed. With the graphite acting as a moderator to slow down the neutrons, nuclear fission occurs and heat energy is generated. This heat is transferred by blowing carbon dioxide gas **3** up through the channels and then passing it in ducts **4** from the top of the reactor in to the eight boiler units **5** that serve each reactor. Here it passes over the boiler pipes converting the boiler system water **6** into superheated steam, **7** and then by use of an electrical motor, the gas is blown back into the bottom of the reactor **8** thus completing the circuit.

The normal operating temperature of the uranium fuel inside the reactor is 420 degrees celsius and this is maintained by controlling the extent of the chain reaction. The core is divided into eight *slices* with a section in the centre, and each of these sectors has boron steel control rods **9** which will absorb the neutrons. Motors move the control rods up and down inside the core thus constantly adjusting the neutron numbers. If the core temperature is too high, then the control rods are lowered into the reactor to absorb neutrons thereby causing the chain reaction to die away. Conversely if the temperature is too low, then the control rods are withdrawn from the core allowing increased fission and thereby increasing the temperature. By the careful movement of the control rods the reactor temperature is controlled to within one degree.



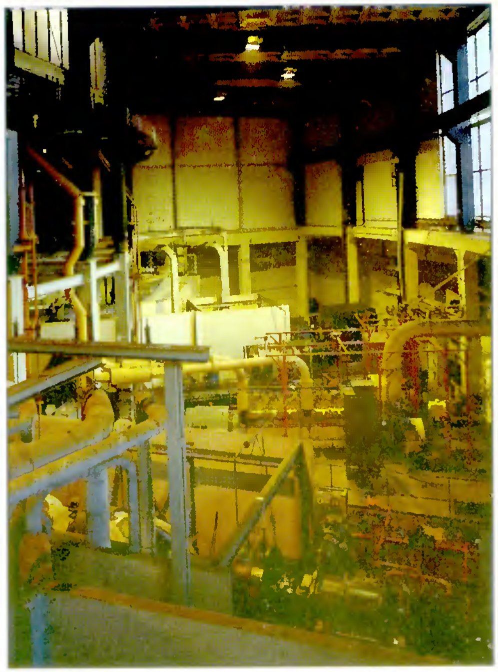
The graphite core, which is constrained by a steel restraint, is housed within a cylindrical 7.5cm thick steel pressure vessel, over 9 metres high and 14.63 metres in diameter. The whole pressure vessel is surrounded by a concrete biological shield at least 2.6 metres thick. This acts as a barrier against the radiation nuclear fission produces.

The floor that can be seen when looking down onto the reactor from the observation gallery is called the pile cap. It consists of a number of steel floor slabs 7.6 cms thick. The motors that drive the control rods are underneath the pile cap floor. If there is a fault in any part of the production system – whether it is the cooling water plant, turbines, boilers or reactors, the chain reaction can be terminated within a matter of a few seconds by use of 112 additional control rods. These control rods are physically held out of the reactor by a system of catches. If a fault were to develop, the reactor would automatically trip, and the control rods immediately fall into the core under gravity, absorbing the neutrons and thus stopping the chain reaction.

A second shut down system is available as a back-up to the control rods. This system consists of a large number of marble sized boron steel balls which can be admitted to the core through special channels. The balls act in the same way as the control rods in that they stop the chain reaction by absorbing the free neutrons.

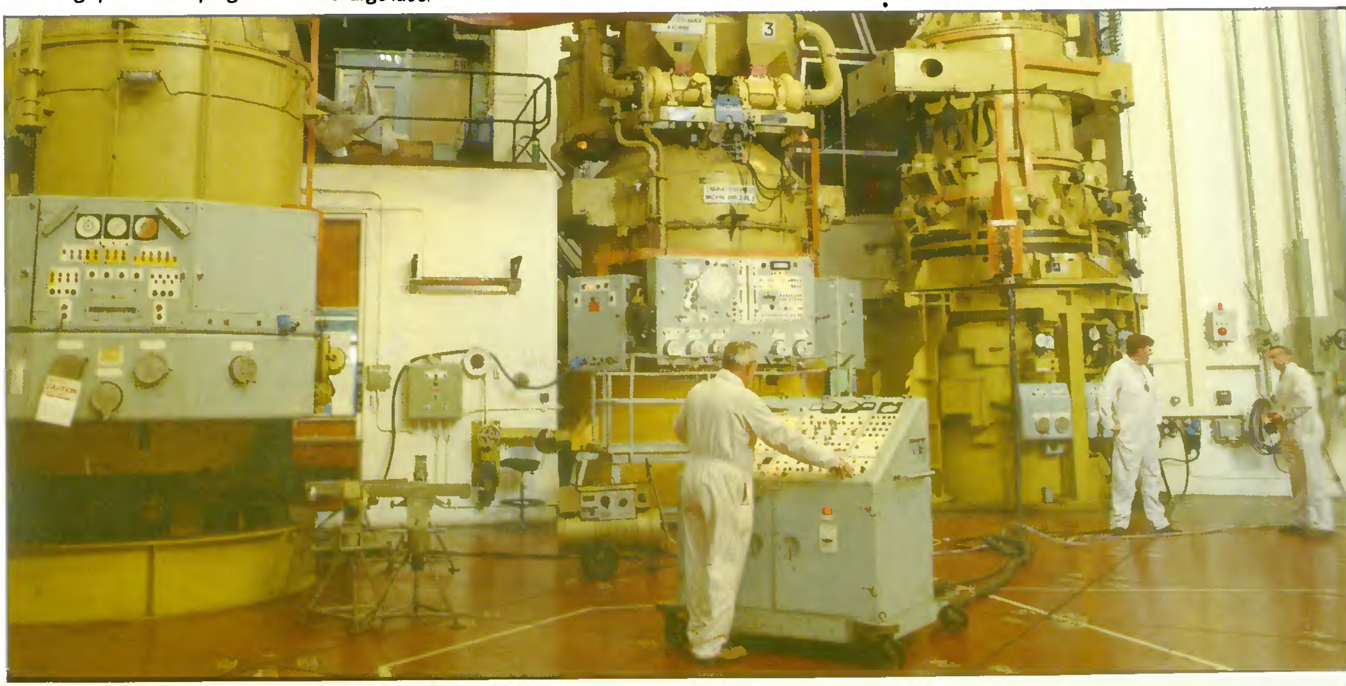
The reactor has a third separate safety system which consists of a quantity of boron carbide dust which can be blown into the core. This is a last resort system as once injected into the core, the dust could not be recovered and the reactor could not be used again.

Four of the boilers which serve No. 2 reactor.



Carbon dioxide is pumped through the core by gas circulators.

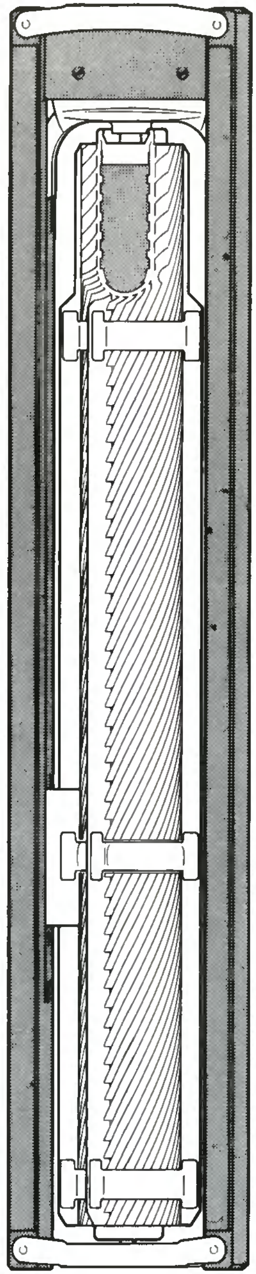
Refuelling operations in progress on the charge face.



FUEL ELEMENTS

Berkeley is known as a "MAGNOX" nuclear power station, the title magnox coming from the canning material around the uranium fuel. The can is made from MAGnesium alloy that will Not OXidise in carbon dioxide. The canister allows the heat generated in the uranium fuel rod to pass through it, but keeps the uranium and fission products sealed inside. The rod of natural uranium is 48 cm long and 3 cm in diameter. The canister is finned to allow efficient heat transfer to occur. Two graphite struts support the fuel element in the channel.

The elements are manufactured by British Nuclear Fuels in their factory at Springfields near Preston in Lancashire. The elements do not emit much radiation before they are used: however, each element is checked to make sure that it is in perfect condition, and gloves have to be worn as even a small amount of dust or perspiration might lead to some corrosion of the canister. This checking procedure takes place in the fuel preparation room next to the reactor. Each element is numbered by the manufacturer, and this number is noted before the element is passed through to the recharging machine to be placed into the core of the reactor.



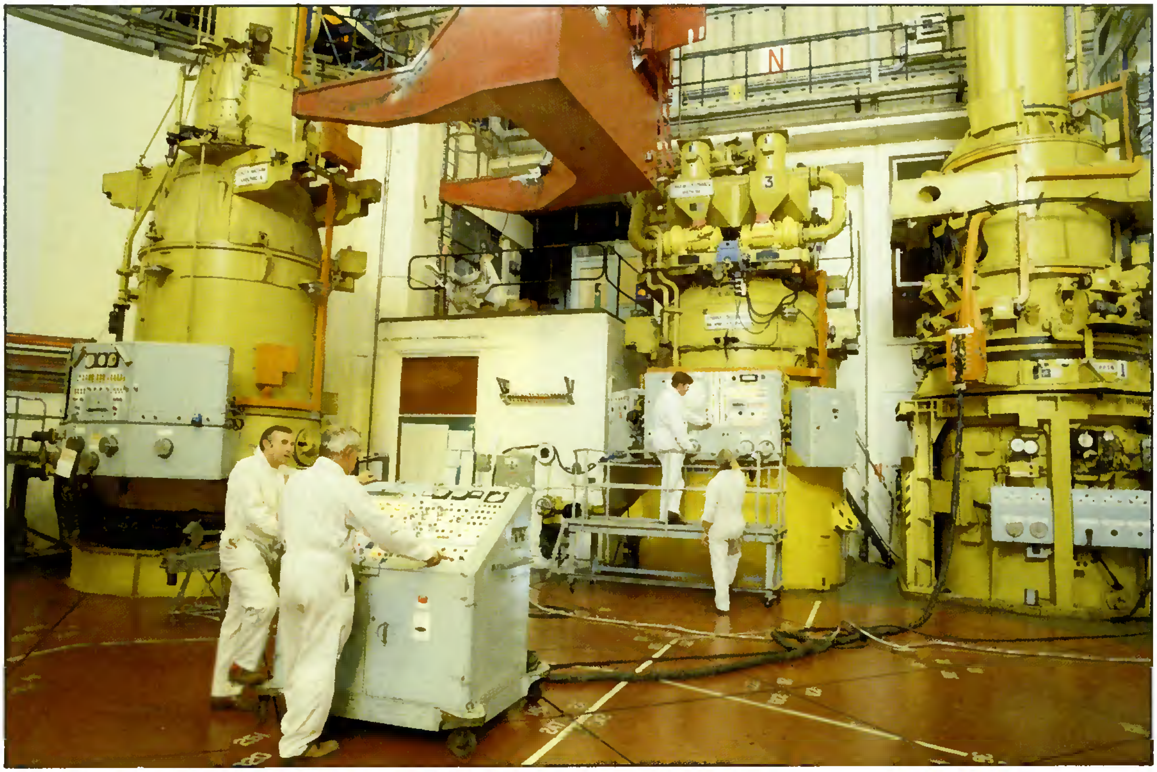
Fuel Elements – Did you know?

– Fuel elements are sometime called fuel rods.
– Each reactor contains 42,445 fuel elements.
– The fuel elements near the centre of the reactor have a life of about 6 years, and those on the outside about 9 years.
– Each fuel element contains 0.7% Uranium 235 and 99.3% Uranium 238.
– Uranium 238 will not 'fission' in a nuclear reactor.
– Each element weighs 11 kilos.

Loading elements in the fuel preparation room.

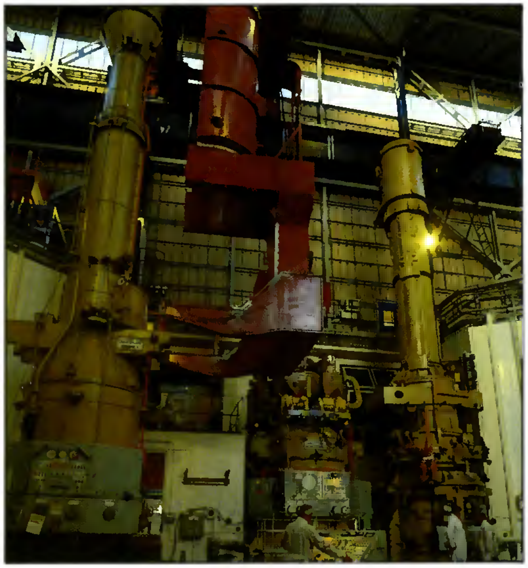
The new fuel store.

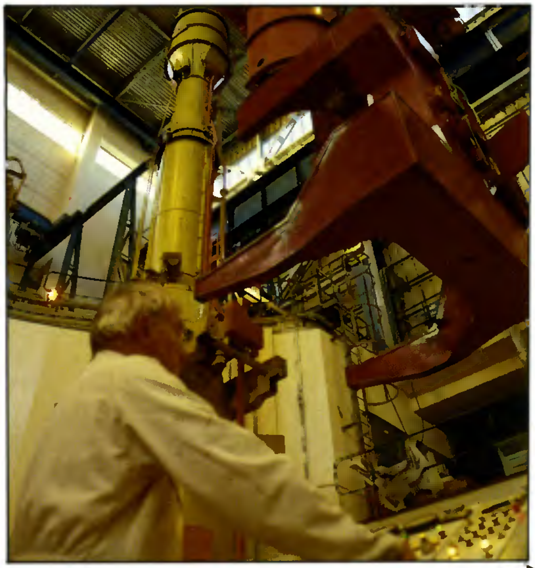
REFUELLING



The charge machine is loaded with new fuel.

The overhead crane lifts the machinery into position.





Uranium 235, the fissile part of uranium fuel, is slowly used up in the reactor and has to be replaced with fresh fuel. This operation is carried out by using a family of special machines. These are placed into position over the core by the use of an overhead crane. The reactor core is accessed by making use of one of the 60 standpipes which provide entry through the steel pressure vessel and thus to the fuel channels.

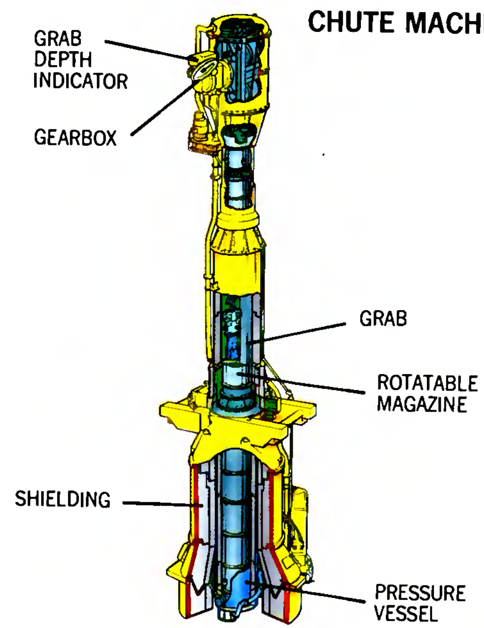
A machine known as VORE (Visual Observation and Recovery Equipment) lets cameras down into the core of the reactor and also has a small grab which can be used to remove small irradiated items. The control rods can be replaced through the use of a machine called CRASM (Control Rod Actuator Servicing Machine).

The first machine to be employed in the refuelling process is the CHUTE machine. After two pile cap shielding slabs have been taken away, the overhead crane lifts a metal skirt into position over the appropriate standpipe. The chute machine is used to take the two radiation shield plugs out of the top of the reactor which are then safely stored inside the machine. A long chute (which has its own shield plug) is then placed down into the top of the reactor. The overhead crane next lifts the CHUTE machine away, and the CHARGE/DISCHARGE machine is placed precisely in position over the chute that has been left behind. After removing the shield plug, the charge/discharge machine takes highly irradiated fuel elements out of the reactor. A grab is lowered from the machine down the chute and into the fuel channel. It picks up the stacked elements one by one and places them into a magazine in the centre of the machine.

After all 13 elements from the channel have been placed in the magazine, the chute is re-plugged and the whole machine (which weighs over 100 tonnes) is lifted over the discharge well, sited to the side of the reactor. As the spent fuel elements are now highly radioactive, the charge machines have their own shielding device to protect the staff – its walls are 35.5 cms thick. The elements are also very hot which requires the machine to have its own cooling system using carbon dioxide gas. After a short period of cooling, the elements are discharged one at a time down the well, and by use of a television monitor the number on the element is checked off. The elements are placed in a shielded flask, the cantilever lid is closed, and the flask travels by a remote controlled mechanism along an underground rail track directly to the cooling pond building.

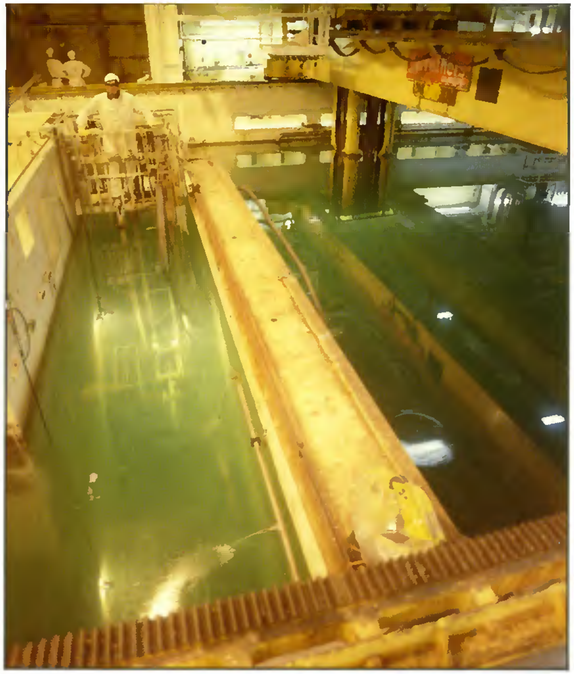
New fuel elements are carried by a conveyor from the fuel preparation room. The elements are lifted from the conveyor and placed into the magazine of the charge machine. Once loaded with new elements, the charge machine is lifted back over the chute and the elements are placed into the empty fuel channel. When this process is completed, the chute machine is brought back, the chute is withdrawn from the top of the core and housed back inside the chute machine, the two plugs replaced and after a number of safety checks the refuelling process is completed. This operation takes about three hours for each channel to be refuelled.

CHUTE MACHINE



COOLING PONDS

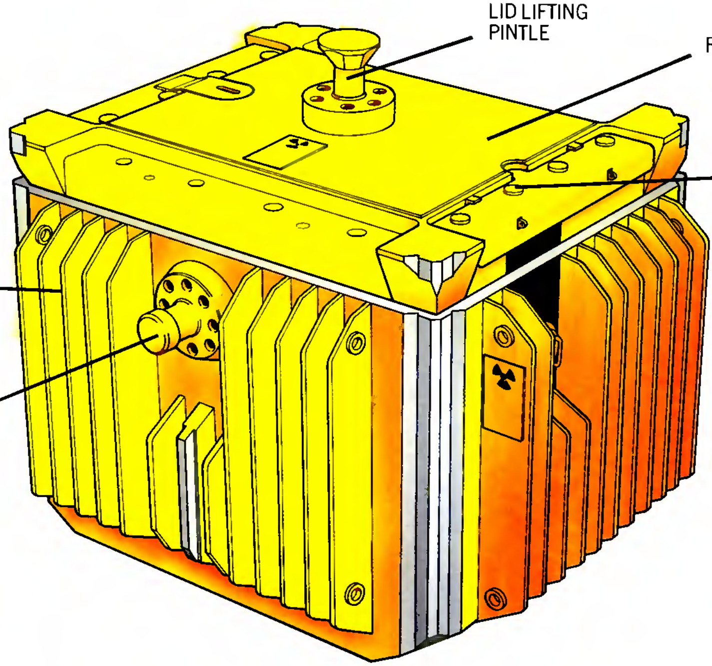
Unused element skips in an empty storage pond. A fuel transport flask can be seen behind skip 7023.



The spent elements are stored underwater in skips in the cooling ponds. When they first come from the reactor core the elements are both physically and radiologically hot. By storing them, short lived radioactive isotopes decay away.

The cooling ponds are over 6 metres deep and contain water that has been purified in a special de-mineralising plant, and is cooled to a constant 10 degrees celsius. Furthermore, in order to prevent corrosion of the magnox canister, the water is kept slightly alkaline.

FUEL FLASK



FUEL TRANSPORT FLASK

After a period of at least 90 days' cooling, the spent fuel elements are taken to the Sellafield reprocessing factory in Cumbria, where the unused uranium is separated out and recovered for future use. During this process, the waste products of fission are recovered. This is *high level* radioactive waste which is at present stored in special tanks at Sellafield.

An underwater machine removes the splitters and struts from the elements, which are then put into a special skip. A transport flask is lowered into the pond, and the overhead crane then lifts the skip into it. The lid is lowered down and fixed on leaving pond water inside to cover the fuel. The flask is then slowly lifted out, being constantly checked for any radiation. It is then held up and carefully sprayed to remove the pond water. Next the flask is degreased and decontaminated and placed in its own monitoring bay. Here, it is scrubbed clean and dried, and the nuts and bolts are clamped down using enormous pressure. Finally, it is checked thoroughly again to see that it is completely clean and safe to be transported. The flask is then lifted out and lowered onto a low loader transporter. It is

FLASK TRANSPORTATION

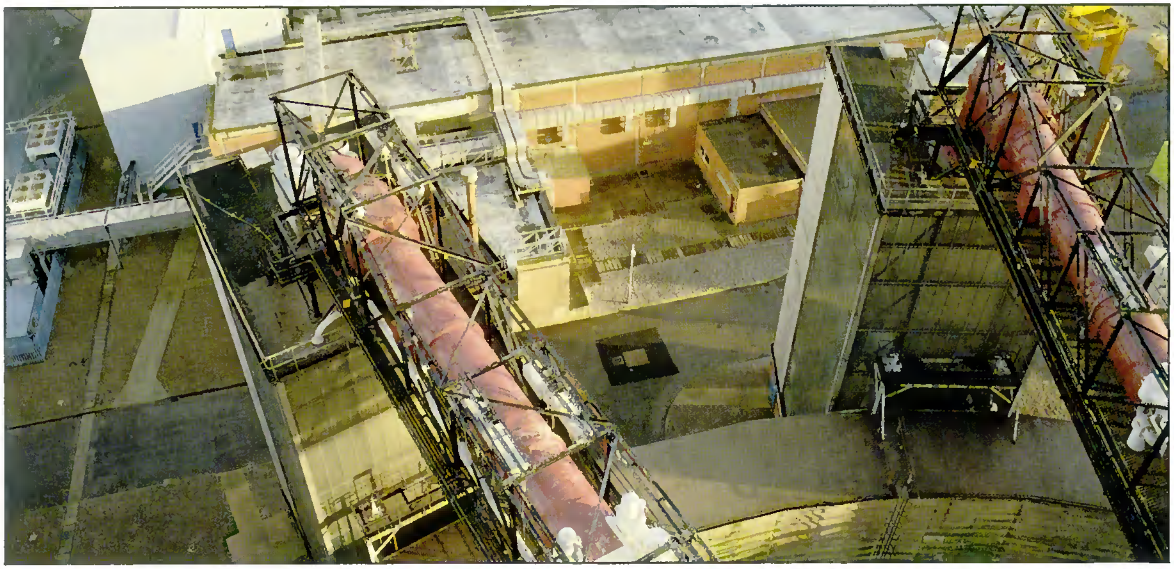
In a demonstration to show the strength of the fuel flask, a television audience of millions saw a diesel train travelling at 100 m.p.h. crash into a flask. The diesel locomotive was destroyed... but the flask was unscathed.

The fuel flasks are carried individually by rail to Sellafield.

checked once more when it leaves the reactor area, and is taken to Berkeley Railhead where it is checked again before being placed onto a special train to be carried by rail to Sellafield.

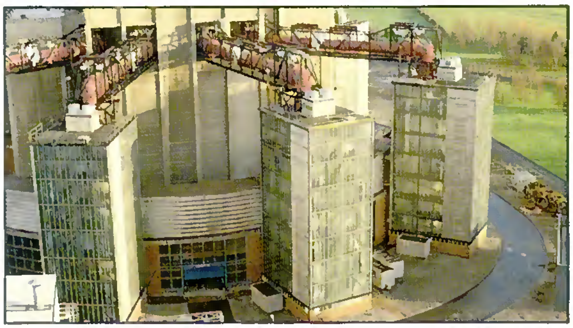
Even after cooling the used fuel elements are still highly radioactive. The flasks used are therefore extremely strong, thick walled steel containers, weighing over 49 tonnes and made from a solid piece of forged steel which is 35cm. thick. The flask must be able to withstand a 9 metre drop onto solid concrete, and exposure to a fire burning at 800 degrees celsius.

BOILERS



The hot carbon dioxide gas is carried from the reactor...

into the boilers...where water is heated to steam...



...and carried by pipes to the turbine.

The water used to drive the turbo-generators is purified in a special plant on the site. This expensive process is necessary in order to prevent corrosion of the boilers. The water is heated within the boilers by carbon dioxide gas circulated from the reactor, and high and low pressure steam is produced. Producing steam at two pressures improves the efficiency of heat transfer. The steam droplets pass up to the top part of the boiler where the gas is at its hottest. Here the steam is superheated and becomes dry. It is necessary to use dry steam within the turbines as water droplets could cause erosion of the blades.

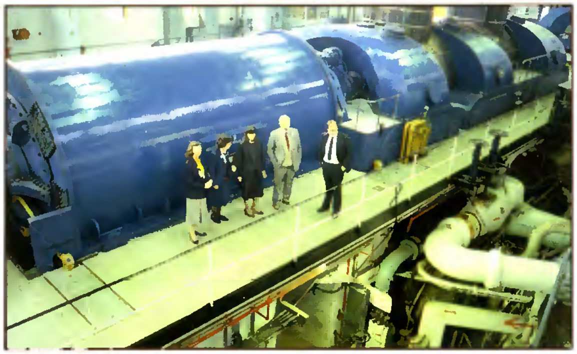
There are four turbo-generators each having 83,000kw capacity. Within each turbine there are a number of sets of blades, designed for different pressures of steam. High pressure steam enters the turbine from underneath, and after passing through the first section of blades, it mixes with the low pressure steam to drive an intermediate set of blades. The flow of steam is then divided, one third passes straight through into the low pressure stages, and two thirds travels through the cross-over ducts and down into the low pressure section where the blades are the biggest. The force of the steam on the blades causes the central shaft to rotate at a constant speed of 3,000 revs. per minute.

The steam is exhausted into one of three condensers that serve each turbine. Here it passes over a system of pipes containing the cold river water which condenses the steam back to water. Before travelling back to the boilers, the condensate is reheated to 77 degrees celsius which increases the efficiency of the system.

Michael Faraday put a piece of wire between the poles of a magnet and found that an electrical current could be induced in the wire. In power stations the same principle applies, but here magnets are spun inside the coils of wire. Direct current is fed to the rotor thus energising the huge electromagnets, and as they rotate inside enormous coils of copper wires the electricity is produced within the wires.

The 132kv grid sub-station.

Electricity is generated at 11.8kv but it is transformed up to 132kv before passing through one of four substations – two in Cirencester, one in Gloucester, and one in the Forest of Dean. From these substations, the electricity joins the National Supergrid.



Routine maintenance on the turbo/generator exciter.

CONTROL ROOM

The control room is manned continuously and as the name suggests, it is the place from where all essential plant is operated and monitored. Each reactor has a separate control desk. Various panels and dials show everything that is happening within both reactors and boilers. Computers are used extensively to check many of the station's safety systems including an alarm analyser which draws the attention of the control engineer to any new readouts being displayed.

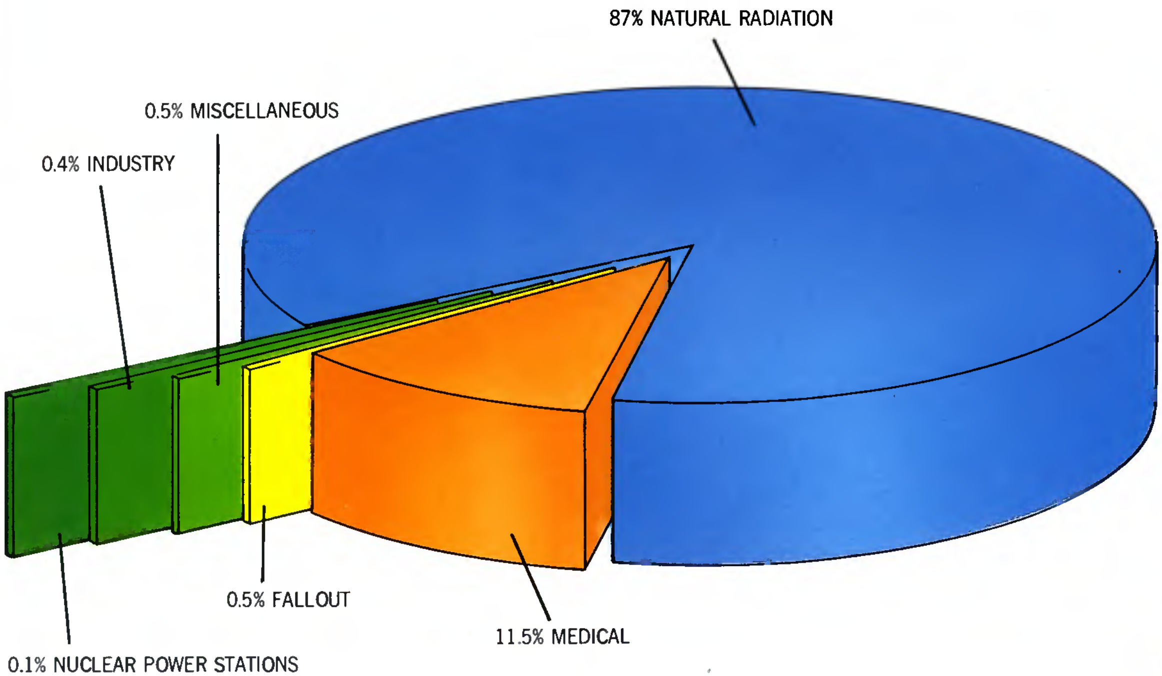
RADIATION

At Berkeley, the process of nuclear fission changes the atoms in the uranium metal, and as this happens both heat and radiation energy are produced. However, people living near the power station receive little or no radiation exposure from this process.

The public's main source of radiation exposure is from natural radioactivity which has always been present. This is known as background radiation. Many rocks are slightly radioactive and there is a tiny amount of uranium in some soils. We get some radiation from outer space, and also from the sun, which is an enormous thermo-nuclear reactor that has been operating for many millions of years.

Man made radiation is produced in many ways other than by nuclear fission. In fact 99.9% of all radiation we receive comes from sources other than our nuclear industry which accounts for just one thousandth of the total. The best known source of man-made radiation is X-ray equipment used in hospitals, and this adds up to almost 90% of man-made exposure in the United Kingdom.

AVERAGE RADIATION EXPOSURE TO A PERSON IN THE U.K.



NUCLEAR SAFETY

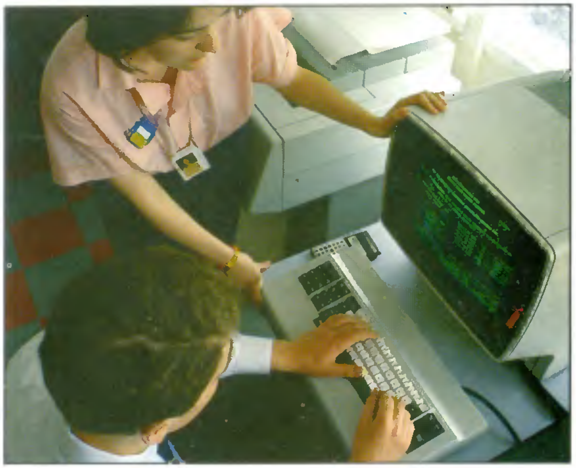
All industrial sites have to obey the very many laws that we in Britain have regarding safety. A nuclear power station has to comply with many extra laws, rules and instructions. The first priority of the CEGB is to make sure that all its power stations operate with absolute safety in mind. Since the first nuclear power stations began generating electricity in 1962 there have been no accidents in any CEGB nuclear power stations to give rise to any danger to the public.

The first safety factor lies in the design of our nuclear power stations. Berkeley was constructed only after the most detailed consideration was given to the design by many safety authorities. All suppliers of nuclear plant have their working practices assessed by CEGB specialists before contracts are given. At each stage of development and construction, all aspects of the building of the station remained under the scrutiny of the Nuclear Installations Inspectorate, who carried out their own inspections as well as witnessing CEGB installation tests. No changes of any sort are allowed to be made to the reactors, nor can any of the equipment to do with safety be altered in any way without the approval of the NII.

CEGB operating standards are such that all senior and technical staff go through rigorous training before being allowed to operate the reactor. The Nuclear Installations Inspectorate vet the qualifications, experience and training of key personnel in the station. The CEGB training centre at nearby Oldbury provides regular courses in such subjects as nuclear safety, operations, maintenance, chemistry, health and reactor physics.

Furthermore, a reactor is only allowed to operate for a period of two years. After that it has to be shut down completely and meticulous internal inspections and maintenance checks are carried out. This takes between 2 and 4 months, and only when it is completed to the satisfaction of the safety authorities can a licence to operate be given, but only for a period of a further two years.

Training is provided for workers in the controlled area who occasionally wear protective clothing, including respiratory protection.



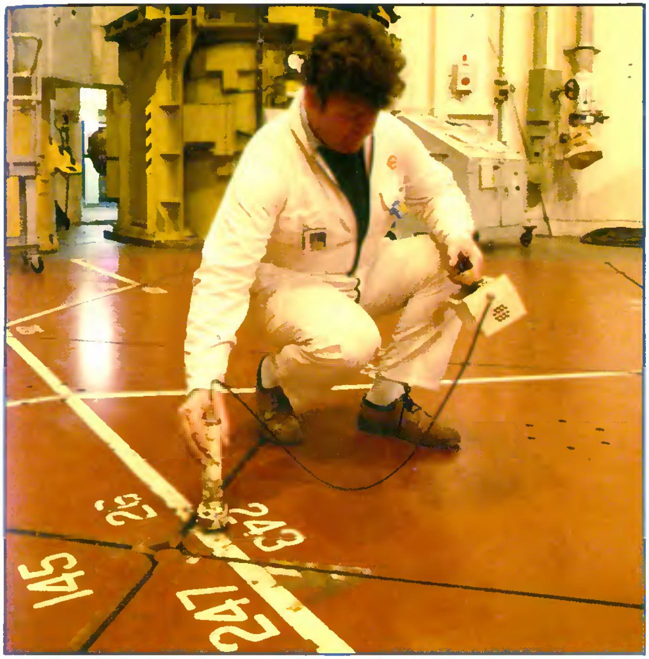
The station's physicists continually assess the safety of the reactor.

PERSONAL PROTECTION

People who work regularly with radiation have to wear a personal radiation dosemeter, the film badge. These include radiologists, gas pipe welding inspectors, civil aircraft engine checkers and many others. At Berkeley, each person who works in the reactor buildings has a badge. Additionally a Direct Reading Control Dosemeter (DRCD) which measures and displays the amount of radiation dose may be worn. This aids the control of occupational radiation exposure by indicating the dose received while doing a particular task within the reactor building. The DRCD provides an instant readout and also has an alarm built into it. This instrument is also issued to a visiting party to confirm that the dose received is insignificant, and is normally worn by each guide.

The only access for personnel into the reactor controlled area is through the Main Change Unit. This serves as the final monitoring point for contamination before leaving the reactor area. When leaving the reactor controlled area, every person is checked in a whole body monitor. Every individual item leaving the reactor controlled area including all tools, equipment, vehicles, etc. are checked out of the reactor controlled area by Health Physics staff.

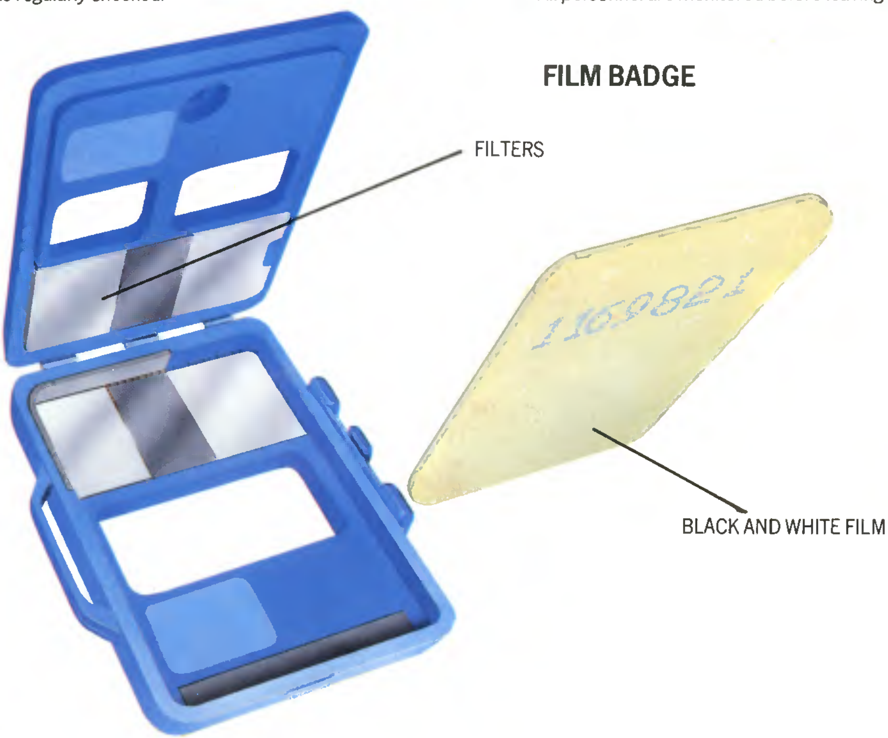
All items are monitored on leaving the reactor area.



Equipment and plant is regularly checked.

All personnel are monitored before leaving the controlled area.

FILM BADGE



ENVIRONMENTAL MONITORING

The area around Berkeley has been monitored for radiation since three years before the station was built, and radiation levels have steadily decreased in that time. This is mainly due to the abandonment of atomsopheric testing of nuclear weapons.

Information is constantly collected by the station Health Physics department who keep a careful watch for changes in radiation in the whole region. Over 3,000 measurements and samples are taken every year in the surrounding area. These include fish, seaweed, silt, and water from the river. Vegetation samples are taken – grasses, soil, milk and other produce from a number of local farms. Finally, by using a Deposition Collector, (Tacky Shade) which can pick up impurities in the air, any airborne radioactivity could be detected.

The samples are analysed at a nearby CEGB laboratory and the results are sent to a number of Government departments including the Ministry of Agriculture, Fisheries and Food, and the Department of the Environment. These organisations carry out independent monitoring to confirm the CEGB results. CEGB samples are taken near the station, and in the surrounding areas up to a distance of 20 miles away. Readings taken close to the station are no higher than those taken from further away.

Samples are taken of mud and seaweed from the river...

...and of grass, soil and vegetation.

Airborne dust is monitored with a "tacky shade" collector...

...and analysed in the laboratory.

LOCAL LIAISON

A liaison group was established as long ago as the late 1950's in order to keep people in local communities fully informed of the activities of the three nuclear sites of Berkeley Power Station, Oldbury Power Station and the Berkeley Nuclear Laboratories. Regular meetings occur in turn at each of the sites to consider nuclear issues and other matters relating to the running of the three establishments.

Members and officers representing all the local District Councils and the County Councils of Avon, Gloucester and Gwent attend the meetings along with representatives from Health Districts, Fire Service, Police, Water Authorities, Nuclear Installations Inspectorate, Department of the Environment, Ministry of Agriculture Fisheries and Food, the Welsh Office and senior power station staff.

At the meetings, the managers of the three sites provide a detailed report on the operation of their plant since the last meeting, and results of environmental monitoring are reported. The managers answer questions which could cover any aspect of the operation of their respective establishments and their relationship with the local community. In order to keep the public fully informed, minutes are distributed to local libraries and representatives of the press attend the meeting.

All CEGB nuclear establishments Emergency Plans and Station Handbooks are available to the public. Copies are held in Berkeley town library in the local collection.

An important aspect of this work is the provision of information regarding the operation of the station's emergency plan, which in accordance with statutory requirements specifies the precise action to be followed by CEGB personnel and other organisations in the event of an emergency. Power station staff receive regular training in emergency procedures, and the emergency plan routines are tested annually by a full exercise. This is scrutinised and monitored by the Nuclear Installations Inspectorate, and the results of this exercise are reported to the meeting at which copies of the emergency plan and handbook are distributed.

The Central Electricity Generating Board co-operates with local authorities and emergency services in the preparation of their own emergency procedures, and joint training exercises are carried out.

GLOSSARY

Atom
The smallest unit of an element that retains the characteristics of that element, and cannot be decomposed by chemical means.

Canister
The magnesium alloy canister in which uranium fuel is sealed to prevent contact with coolant gas or the escape of radioactive fission products. The canister is finned to increase the rate of heat transfer.

Chain reaction
A self sustaining process in which, in the chain reaction of nuclear fission, neutrons cause nuclear fission in uranium atoms producing more neutrons, which cause further fissions and so on.

Control rod
A neutron-absorbing boron steel rod which is moved in or out of the reactor core to control the number of neutrons available for fission, and hence the power level of the reactor.

Core
The central region of a nuclear reactor containing the fuel elements where the chain reaction of nuclear fission is carried on.

Electron
One of the fundamental constituent particles (see proton, neutron) of an atom, around whose nuclei they revolve in orbits. It carries a single unit of negative electric charge.

Energy, radiation
Energy in the process of transmission as electromagnetic waves or particles: all the ways in which an atom gives off energy.

Fission
The process in which an atomic nucleus is split into two approximately equal fragments and a number of neutrons, with the liberation of a large amount of energy.

Moderator
The material used in the reactor to reduce the energy and speed of the neutrons produced as a result of fission. In the case of Berkeley the moderator is graphite.

Neutron
One of the fundamental constituent particles (see proton, electron) of the nucleus of an atom, having approximately the same mass as a proton, but being electrically neutral.

Nucleus
The core of an atom, composed of protons and neutrons, occupying little of the volume, containing most of the mass, and bearing positive electric charge.

Proton
One of the fundamental constituent particles (see electron, neutron) of an atom, having the same mass as a neutron, having positive electric charge.

Radiation
see Energy, radiation.

Reactor
A structure, or part of a plant in which a neutron-induced chain reaction of nuclear fission can be maintained, controlled, and used.

Stand pipe
A pipe which provides access through the concrete pressure vessel to the reactor core for control rods and the refuelling process.

Uranium, natural
A metallic element (symbol U) malleable and white in colour, and mined as an ore. One of the few natural elements whose atoms will sustain a fission chain reaction easily, and is therefore used as the fuel to produce nuclear energy.

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The CEGB publishes a range of materials that are available at no cost to support schools in topics relating to energy production. Details can be obtained from:
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Dept. of Information and Public Affairs,
Bedminster Down, Bridgewater Rd.,
Bristol BS13 8AN.

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