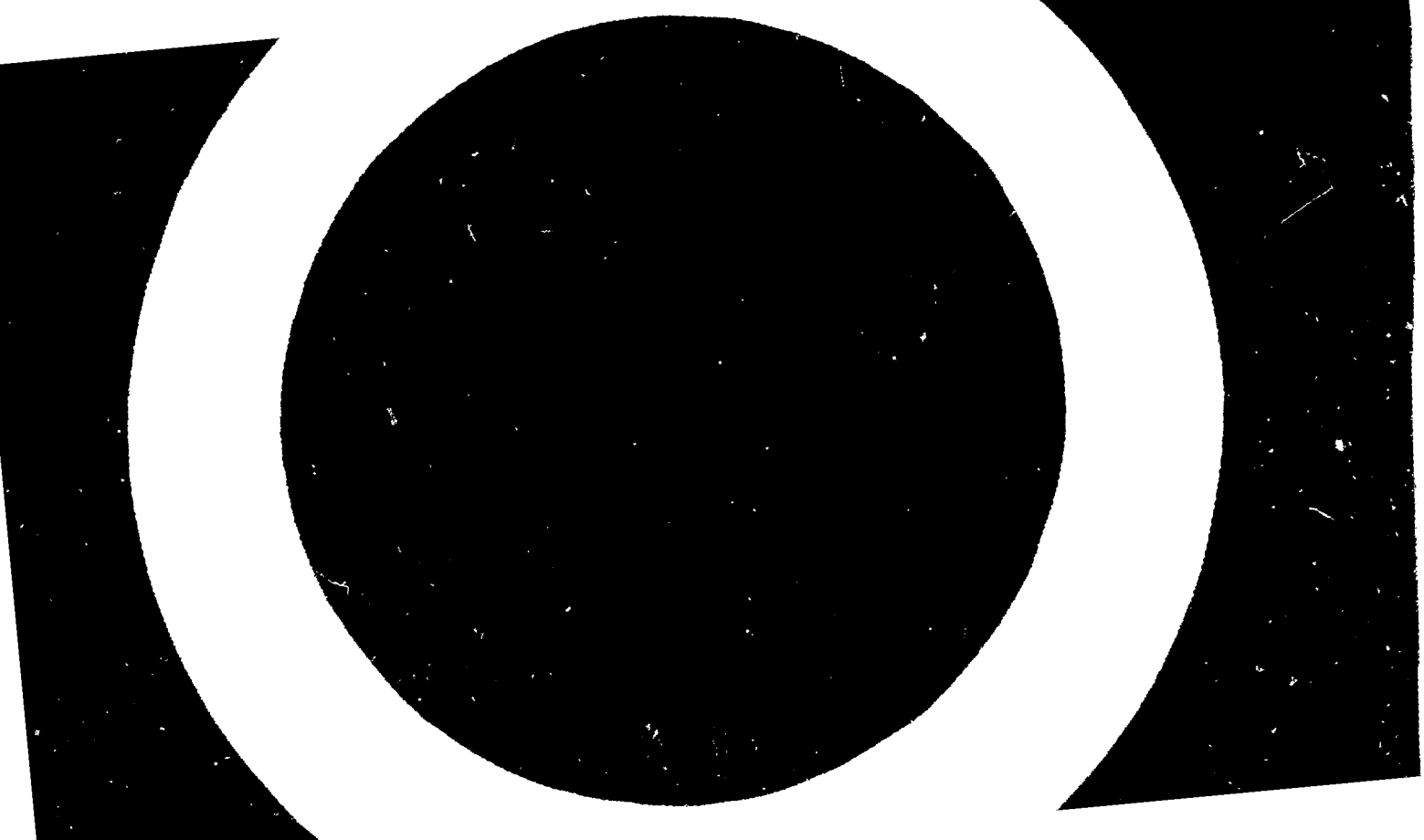

REACTOR RESEARCH CENTRE, KALPAKKAM, FAST BREEDER TEST REACTOR

India's nuclear power programme based on natural uranium and thorium occurring in her soil is now on a firm footing. 2 CANDU-type thermal reactors using natural uranium as fuel and heavy water as moderator and as coolant, are under construction at Rana Pratap Sagar in the State of Rajasthan, and one such type at Kalpakkam, 80 km south of Madras. Each of these 3 reactors is capable of producing about 200 MWe of nuclear power. It is well-known that a by-product of these power reactors will be plutonium, itself a valuable nuclear fuel.

The great advantage of nuclear power for India's future lies in the large deposits of the fertile materials thorium and uranium within her boundaries. However, 99.3% of all naturally occurring uranium is uranium-238 and only 0.7% the usable fissile isotope uranium-235. In spite of this, by converting uranium-238 and thorium-232 into fissionable plutonium and uranium-233 through the action of neutrons in a reactor, the resources of the country with respect to nuclear power can be greatly augmented.

In other parts of the world, programmes for the utilisation of the fertile materials to breed nuclear fuel in excess of what is consumed in reactors known as Fast Breeder Reactors (FBR) have been initiated. Prototypes of breeder reactors are now in operation in countries like Britain, France, USA etc. It is obvious that India cannot afford to lag behind in developing this technology, because of her large deposits of thorium, which can be converted in such reactors into uranium-233.

In a fast reactor the conditions of nuclear reactions are optimised to convert the fertile material into fissile material. Conventional cooling agents like water cannot be used in these reactors and the heat is usually removed by a liquid metal like sodium. The handling of large amounts of liquid sodium is in itself a new technology, which needs stringent conditions of purity at the large radiation levels found in a fast reactor. In order that Indian scientists and engineers should gain experience in the design, construction and operation of fast reactors which are expected to be in operation throughout the world in 1980's, the Department of Atomic Energy (DAE) is setting up a Reactor Research Centre (RRC) near Kalpakkam, the site of the Madras Power Station. One of the important facilities at this Centre would be a small Fast Breeder Test Reactor (FBTR), which would incorporate maximum possible parameters of a large prototype power reactor.

FBTR will use a mixture of plutonium oxide and uranium oxide as fuel; the power produced will be 50 MW thermal. Two closed circuits of liquid sodium will remove the heat produced in the reactor and generate steam at 480°C and 124 atmospheres pressure. This steam in turn will be utilised to run a turbo-generator and produce 15 MW of electric power.

The reactor proper is basically similar to the RHAPSODIE Reactor at Cadarache in France, but modified for power generation. The Indian Atomic Energy Commission (AEC) is in cooperation with the French Atomic Energy Commission in this programme, and a team of scientists was sent to France in 1968 for preparing a preliminary project report from the experiences gained by the French Commissariat A l'Energie Atomique (CEA) in operating their reactor RHAPSODIE. On the basis of the preliminary report, the AEC has now entered into the second phase of this project to be undertaken with CEA. It will be the responsibility of the Indian Atomic Energy Commission to prepare a complete project report which will detail the design and specifications of all plant components as a guide for firm financial estimate for concluding contracts, and also for carrying out certain detailed studies and tests necessary to define the characteristics of the Indian reactor. An agreement to this effect was recently concluded between the Indian Atomic Energy Commission and CEA, France. In connection with the second phase, a team of 18 Indian engineers and 13 draughtsmen have now been working for about a year in France on the detailed design of the prototype reactor, the major part of the effort from now on being undertaken in India.

According to the agreement concluded between AEC and CEA, the responsibility for the whole project, including the construction of the reactor, will lie with the Indian Atomic Energy Commission and the Department of Atomic Energy. Indian industry will have a maximum share in the engineering of the project and supply of materials and equipment. Thus in building the Fast Breeder Test Reactor at Kalpakkam India will gain considerable technical ability to plan and construct future breeder reactors.

The Reactor Research Centre will have several other facilities like fuel reprocessing and fuel fabrication plants, engineering laboratories, liquid metal technology laboratories, materials research laboratories etc.. A Pulsed Fast Reactor will also form part of the Centre. A suitable research and development programme for the utilisation of the vast resources of thorium in the country will also be initiated here.

Pulsed Fast Reactor and Zero Energy Critical Facility

The Pulsed Fast Reactor is a modern device to produce intense neutron beams at periodic intervals. The reactor consists of a compact core of highly fissionable material like plutonium or enriched uranium, and is made momentarily super-prompt-critical by a pulsation device. This facility provides neutron intensities not easily available in ordinary reactors. The usefulness of this reactor lies in fundamental research where it provides a unique tool to make studies on the dynamic behaviour of atoms in solids, liquids, and magnetic materials and in studies on neutron induced damage in chemical and biological systems. In applied fields it can be used to provide data for a nuclear power programme, based on fast reactors.

A pulsed fast reactor is being designed and developed at the Bhabha Atomic Research Centre (BARC), Trombay, Bombay to be constructed at Kalpakkam as a part of the Reactor Research Centre. The engineering and nuclear design of this facility involves precision of the highest order. Especially, the nuclear part of the design has to be based on previous experimentation and study of the behaviour of the compact core. In this connection, a Zero Power Experimental Critical Facility is being set up at BARC where the actual nuclear behaviour of the reactor core will be tested, and certain nuclear parameters measured.

The Kalpakkam Pulsed Reactor will consist of a compact core of fuel pins of plutonium oxide encased in stainless steel. The average power dissipation will be 30 KW reaching a few Megawatts during the peak of the pulse. The heat generated will be removed by an air cooling arrangement. The pulsation device is part of the reflector which passes one face of the core at the rate of 3000 times a minute, producing 50 pulses per second. Flight tubes several metres long looking at the core and reflector provide neutron channels for experimental measurements.

This project will involve all the nuclear technological competence developed at Trombay, and will lead to advanced knowhow in several aspects of nuclear engineering and reactor control. The facility is expected to be operative by 1973. In addition to its utility in the nuclear power programme, this will also prove a useful facility for stimulating research in the neighbouring educational centres.