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# AEB - HIGHLIGHTS

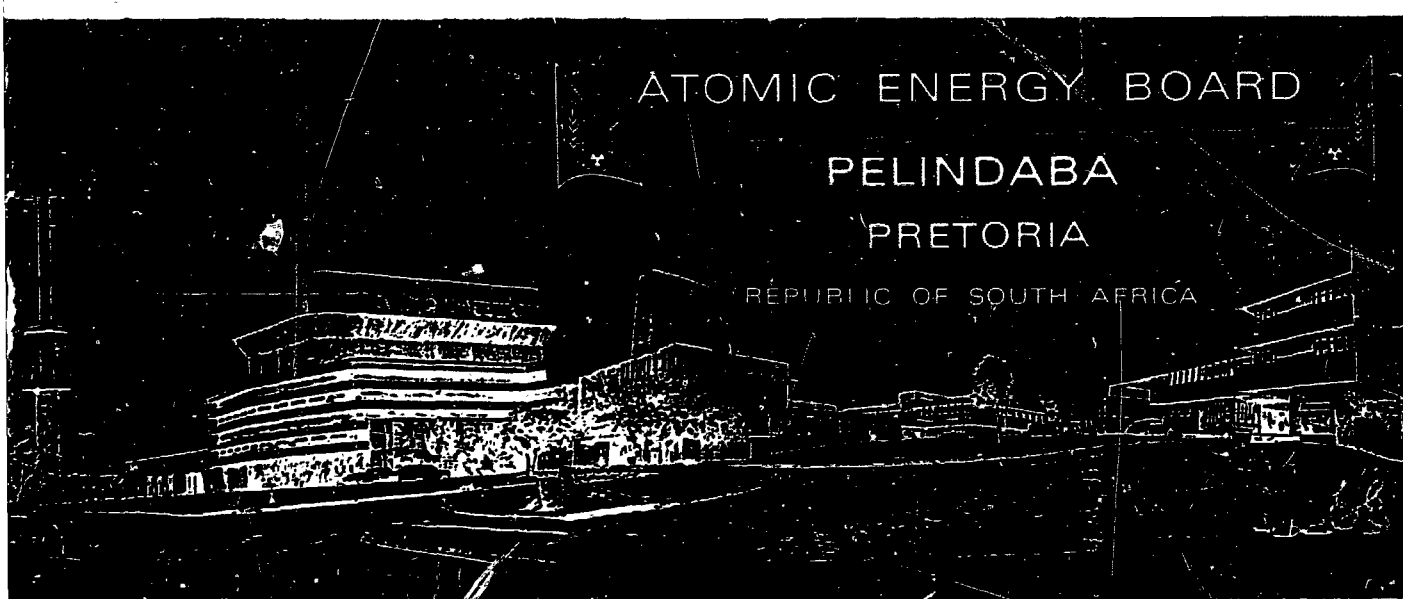
JANUARY - JUNE 1975

ATOMIC ENERGY BOARD

PELINDABA

PRETORIA

REPUBLIC OF SOUTH AFRICA



## **AEB HIGHLIGHTS**

AEB HIGHLIGHTS is a half-yearly report reflecting the most important recent achievements of the various Research and Technical Divisions of the Atomic Energy Board. It appears alternately in English and Afrikaans.

## **RAK-HOOGTEPUNTE**

RAK-HOOGTEPUNTE is 'n halfjaarlikse verslag wat die belangrikste onlangse prestasies van die verskillende Tegniese en Navorsingsafdelings van die Raad op Atoomkrag weerspieël. Dit verskyn om die beurt in Afrikaans en Engels.

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## **GEOLOGY DIVISION**

### **ESTIMATION OF URANIUM RESERVES WITH THE ASSISTANCE OF COMPUTER PROGRAMS**

The Committee on Uranium Reserves has initiated computer programs in order to assess uranium reserves in the various geological formations (especially the more than fifty gold-uranium mines based on the Witwatersrand Supergroup), in a much more sophisticated manner than has hitherto been possible. Such programs would, among other things, also yield information which would make possible case studies in terms of a certain subsidy formula, capital requirement and profitability, and could take any number of other parameters into account.

### **RADIOMETRIC SURVEYS IN THE KAROO BASIN**

That South Africa should be assured of large reserves of uranium within its borders can hardly be overemphasized. Following widespread discoveries of uranium within the Karoo Supergroup, representations have been made to the Minister of Mines by the Director of the Geological Survey, strongly supported by the President of the Board, that, as a matter of urgency, the entire Karoo Supergroup should be aeroradiometrically surveyed as soon as possible. This has been approved and the complete program is being planned and will be executed at a total cost of some three million rand.

### **URANIUM IN THE KAROO SUPERGROUP**

A preliminary investigation of the economic potential of the lowermost beds of the Dwyka Group of the Karoo Supergroup indicated that these beds are at least three times more radioactive than the underlying basement rocks. Some areas are highly anomalous and indicate that the area in general may have some economic potential.

### **GEOLOGICAL CO-OPERATION WITH BRAZIL**

The Brazilian National Commission for Nuclear Energy has proposed a joint investigation of geological and mineral trends along our matching coastlines. This has been approved and the planning of such a program is currently under investigation.

## **EXTRACTION METALLURGY DIVISION**

### **COMMISSIONING OF A PLANT FOR THE PRODUCTION OF URANIUM HEXAFLUORIDE AT PELINDABA**

A plant for the production of uranium hexafluoride (UF<sub>6</sub>) was successfully commissioned at Pelindaba, so that for the first time in South Africa this compound was produced on an industrial scale.

UF<sub>6</sub> is a vitally important material in the production of enriched uranium for nuclear-power purposes. It is the only compound of uranium which is gaseous at normal temperatures and pressures, and is the feed material for all enrichment processes used today, including the enrichment process developed by the Uranium Enrichment Corporation of South Africa Limited (UCOR). It is, however, an extremely hazardous and corrosive substance and highly specialized production techniques have to be utilized. Very stringent safety precautions have to be taken in the design of a UF<sub>6</sub> plant, in the selection of materials for its construction, in the operation of the plant, and in the handling of the product. Sophisticated instrumentation and control systems have to be employed.

Although the Pelindaba plant is not a full-scale commercial plant, it nevertheless makes use of industrial-scale units, so that it will provide invaluable design information and operating experience for a future large commercial plant which will have to be erected to provide the essential feed material to supply the enrichment plant which is envisaged in South Africa. In the immediate future, the plant at Pelindaba will be operated to provide feed material for the UCOR enrichment pilot plant. The total cost of the plant, including the building, was R4,5 million, to which the Uranium Industry of the Republic has made a substantial contribution.

The feed material to the plant is uranium tetrafluoride (UF<sub>4</sub>) which has been produced from South African uranium oxide in a plant established by the Nuclear Fuels Corporation of South Africa Limited (NUFCOR), at its central calcining works at Zuurbekom. The production of UF<sub>6</sub> in South Africa must thus be considered to be a collaborative effort of the Atomic Energy Board and the South African Uranium Industry.

The successful commissioning of this plant is the culmination of many years of intense effort by the Extraction Metallurgy Division of the Board. After an intensive research effort in which many processing techniques were studied, a decision was taken in 1973 to proceed with the erection of the plant at Pelindaba. It is a remarkable achievement that the plant could be commissioned in the short time of two years, and that the South African scientists involved have mastered the extremely complex technology and are now planning further improvements to the process.

## PHYSICAL METALLURGY DIVISION

### COMPATIBILITY OF URANIUM CARBIDE WITH STAINLESS STEELS

During this period the investigation concerning the effect of uranium carbide (UC) surface oxidation on the compatibility behaviour of UC powders with stainless steels was completed and a publication is in preparation. This work has essentially confirmed the model which was previously proposed in PEL-243 to explain the effect of powder-particle size on the compatibility behaviour of UC powders with stainless steels.

In the work on the effect of surface oxidation of the UC powder, it has been shown that even in a stoichiometric UC powder, carburisation of the cladding does still occur from the free carbon which is present in the oxidised surface layer of the UC particles. The transfer of this free carbon to the cladding in the case of a gas-bonded or vacuum-bonded test, occurs through the gas phase by the establishment of a suitable CO/CO<sub>2</sub> partial-pressure ratio in the closed capsule, whereas in a sodium-bonded test the sodium acts as a direct transfer medium for the free carbon from the UC particles to the cladding.

It was further established that in a stoichiometric UC powder the amount of carburisation is dependent only on the amount of surface oxidation of the UC particles, and is independent of the particle size of the powder. This is in contrast to the case where a hyperstoichiometric fuel powder is used (see PEL-243) where a further source of carbon (the UC<sub>2</sub> present in the UC) exists, and where particle size consequently determines the total amount of carburisation of the cladding.

These results indicate that if a vibratory compacted carbide fuel element should ever be considered, stringent control of the stoichiometry and the surface oxidation of the particles would be of vital importance if carburisation of the cladding is to be precluded.

## CHEMISTRY DIVISION

### RADIOISOTOPE-LABELLED COMPOUNDS FOR NUCLEAR MEDICINE

Two sterile, pyrogen-free iodine-131-labelled compounds were developed with great success, and marketing commenced in April 1975; the compounds are Rose Bengal (131I) and Hippuran (131I), used respectively for liver and kidney imaging.

New processing and quality-control procedures were developed; these compare very favourably with those of overseas production centres and ensure products of high quality.

The production cost of the compounds is relatively low, due to limited requirements with regard to labour and apparatus; furthermore use is made of the excess quantities of iodine-131 that have to be produced for supplying 131I solutions.

### TRIAL OVERSEAS SHIPMENT OF MANGOES

Large-scale exports of mangoes to Europe are excluded, due to excessive losses caused by weevil damage and fungal diseases. Repeated simulated-shipping studies have indicated that with a combined radiation/hot-water treatment, losses may be sufficiently reduced to make export feasible. It was subsequently deemed desirable to carry out an actual small-scale shipment of fruit which had been given the appropriate treatment.

Accordingly, a consignment of 60 trays of Kent mangoes given one of three treatments, viz.

- (a) control (hot water, 55 °C/5 min)
- (b) hot water + 75 krad
- (c) hot fungicide + 75 krad,

was transported by rail to Cape Town and then by sea to Southampton. From there they were conveyed by road to Amsterdam for evaluation of fungal disease, degree of ripeness, general appearance and organoleptic properties.

Apart from some minor problems which were pinpointed by the exercise, the operation was successful and it is intended to carry out several repeat operations during the next season to confirm the findings before larger-scale consignments are considered.

### PROVISION OF MANGO PULP FOR WHOLESOMENESS STUDIES

As a voluntary contribution to the International Food Irradiation Project's studies on the wholesomeness of irradiated mangoes, the Atomic Energy Board has undertaken to provide the mango pulp for the proposed feeding studies. Consequently, during the past season 1 400 kg of mangoes, half of which were irradiated, were stored under simulated-shipping conditions, before being pulped and frozen to -15 °C. The contract for the feeding studies has recently been awarded to an organization in Wisconsin, USA, and the pulp will be transferred to this destination.

## PHYSICS DIVISION

### COMPUTING CENTRE

During this period the remainder of the 3330-type disk drives were installed, as well as two display-type terminals, making the time-sharing option (TSO) fully operational. TSO has proved to be invaluable for the development of programs.

### NEUTRON PHYSICS

Excitation of the 40 keV isomeric state in  $^{103}\text{Rh}$  by inelastic neutron scattering has attractive properties for selective fast-flux monitoring. The required accurate knowledge of the cross section for this process and of its dependence on neutron energy, is difficult to obtain from activation measurements. In a recent series of experiments at the Van de Graaff accelerator, the inelastic neutron scattering cross sections for a number of levels in  $^{103}\text{Rh}$  were carefully measured for the first time. The level and decay scheme for this nucleus was also determined in more detail than before. From these results the effective activation cross sections could be deduced. Remarkable agreement was obtained between the final results, derived from detailed microscopic measurements, and one of the existing sets of activation measurements. Several additional interesting features of the nuclear structure and decay properties of  $^{103}\text{Rh}$  are still being investigated.

## ISOTOPES AND RADIATION DIVISION

### NUCLEAR POWER:

#### THE IMPACT ON MAN AND HIS ENVIRONMENT

A special session on nuclear power was arranged on 6th March during the Annual Congress of the South African Association of Physicists in Medicine and Biology, Cape Town. With the collaboration of a representative from ESCOM and Sir Brian Windeyer, Chairman of the United Kingdom National Radiological Protection Board, nine papers were presented, ranging from the nature of radioactive effluents from power reactors to the required radiation protection.

Progress on the pre-operational investigation of safe radioactive releases from the nuclear power station site at Duynefontein, which are being conducted by the Board on behalf of ESCOM, was presented at the first European Nuclear Conference which took place in Paris from 21st to 25th April. It was shown that the capacity of an environment to safely accept radioactive effluent depends on various local factors such as dispersion conditions, the ecology, the habits of the local population and the accumulation by critical organisms of pertinent radionuclides. These factors have been investigated at the coastal site at Duynefontein, 28 km north of Cape Town, where the Electricity Supply Commission intends erecting South Africa's first nuclear power station, Koeberg A.

Surveys and analyses to determine concentration factors for various stable elements in edible marine organisms have led to a determination of the recipient capacity of the marine environment. Full details are presented of the concentration factors and derived working limits for nineteen radionuclides in seawater, as well as the resultant safe release rates.

The effects of atmospheric releases have been investigated by conventional mesometeorological measurements, as well as by newly developed techniques for the actual measurement of dispersion using nuclear tracers, and by radar tracking of balloons.



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