Central Intelligence Agency

Washington, D.C. 20505

DIRECTORATE OF INTELLIGENCE

9 April 1984

South Africa's Turn to Heavy Water Technology: History and Implications [redacted]

[redacted]

[redacted]

* * *

[redacted]

South Africa's History of Interest in Heavy Water Technology

[redacted] According to open literature, in the late 1950s, the first applied research undertaken by the Atomic Energy Board (AEB) was heavy water production technology, and that project had the specific approval of the South Africa Cabinet.

[redacted]

Meanwhile, scientists at SASOL investigated the heavy water enrichment potential of its plant. But, later technical review [redacted] indicated that there was faulty interpretation of the results and the process did not work. [redacted]

South African open literature sources further claim that the overall heavy water effort was oriented around the fact that heavy-water-moderated reactors were regarded as attractive in South Africa due to its vast uranium reserves. [redacted]

South Africa began extensive engineering studies for the Pelinduna concept in 1961. The initial economic study, in 1965, indicated that PELINDUNA reactor components were optimized at a power level of 350 megawatts-electrical (MWe). Scaled down components would be tested in a 30 megawatt-thermal reactor. However, beyond the engineering problems of this unconventional reactor concept, there purportedly was one problem that the South Africans did not believe was resolvable. The high specific power (which is the advantage of using molten salt as a coolant) meant that the smallest effective reactor fueled with natural uranium, which would fully utilize this power, was about 1,000 MWe. At that time, it was deemed unlikely that such a large unit could be introduced into the South African electrical grid within the next 15 years. Therefore, the PELINDUNA power reactor concept was shelved. [redacted]

Still, by the late 1960s, the South Africans considered the generic heavy water reactor type as best suited for South Africa. They then conducted a series of (PELINOMIC) computer-modeled simulations on the efficacy of different nuclear power systems. Because of the uncertainties regarding uninterrupted supply of enriched uranium from abroad, the South Africans only considered natural uranium systems. They concluded that CANDU-type reactors of the 350 MWe size were economically competitive (relative to coal fuel plants) in the Cape region. [redacted]

---------- ----------

[redacted]

However, in 1970, further economic studies showed that South Africa's electrical growth rate had been so steep as to be able to adopt a 1,000 MWe plant. At that time, the South Africans decided to select only proven power reactor concepts. Meanwhile, the enrichment process developed by the South African Uranium Enrichment Corporation (UCOR) allayed concerns about long-term outside sources of enriched uranium. With these findings, AEB turned away from heavy water technology to light water technology. [redacted]

[redacted]

In early 1982, the outgoing head of the AEB, A.J.A. Roux, stated that a plant size of 3 million SWU (separative work units) per year was needed to be competitive in the world market.-3- Since there is currently a large world-wide oversupply of enriched uranium and enrichment plant capacity, the market for general export almost certainly does not exist. Presumably for this reason (and in terms of capital cost of the plant) South Africa scaled down its proposed commercial plant to one-tenth of

---

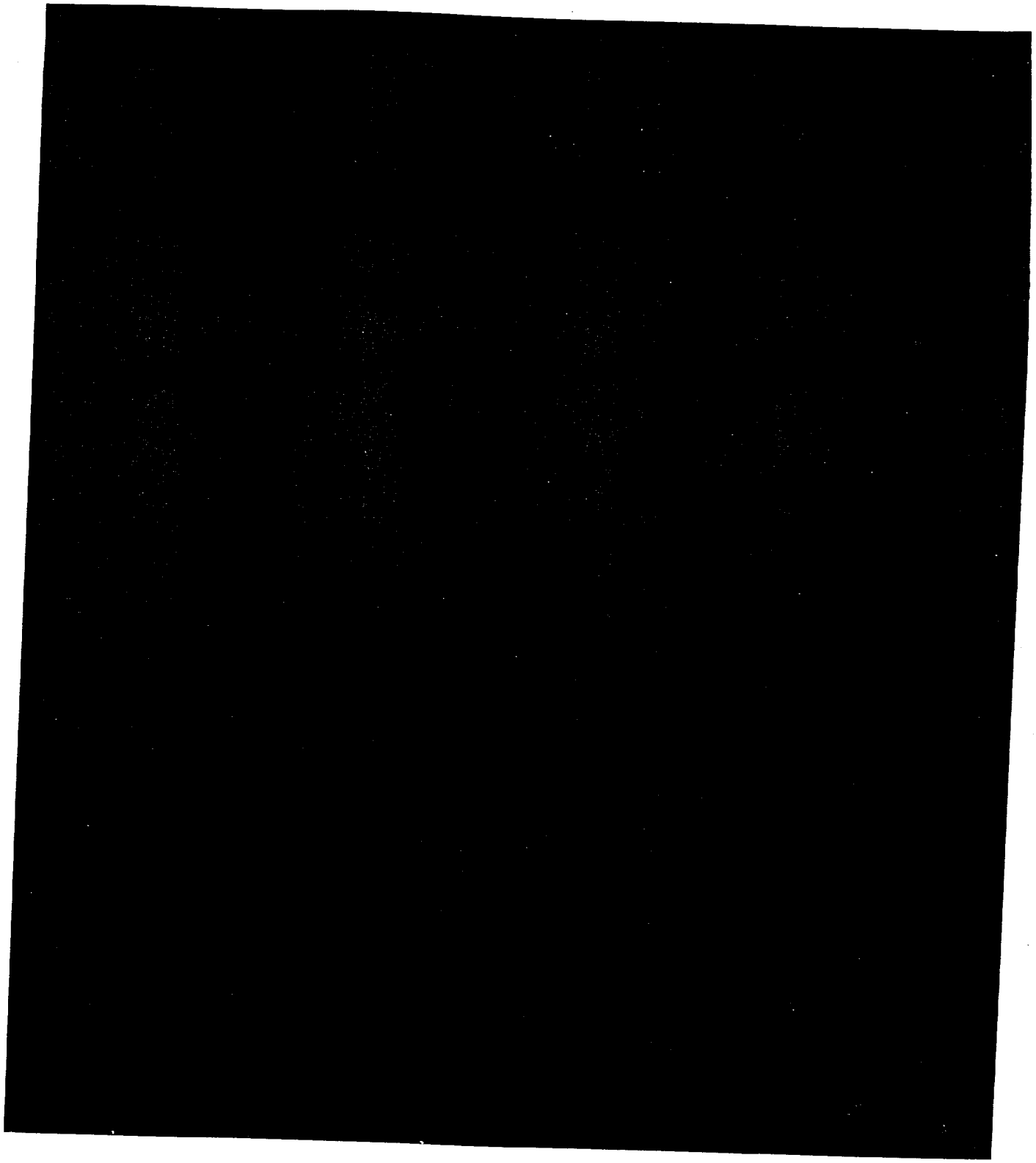
[redacted]

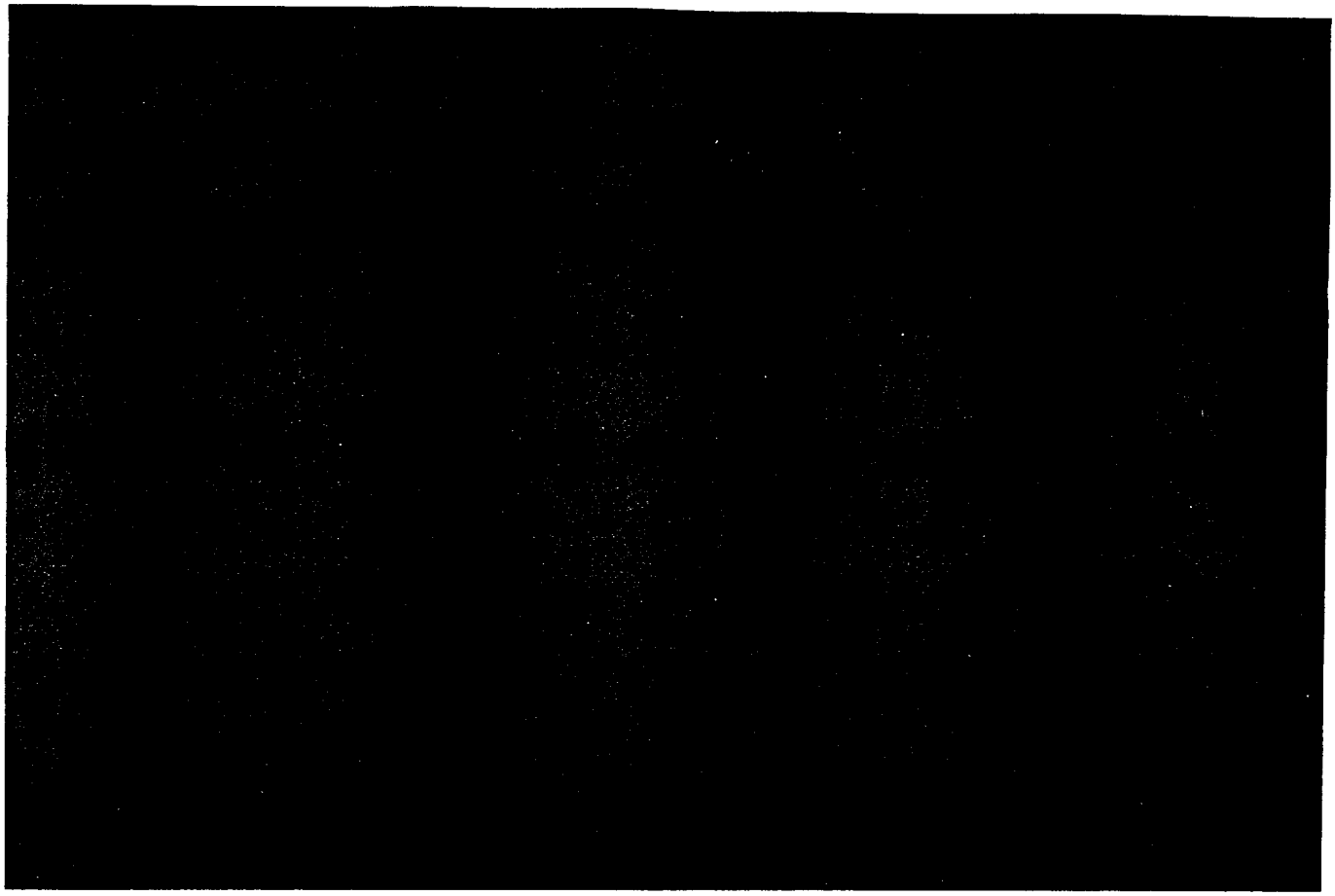
-3- Separative work units provide a means for expressing the effort required to produce a quantity of uranium enriched to a specified uranium-235 (U-235) content from feed material of lower content. About four separative work units are required to produce one kilogram of uranium enriched to 3-percent U-235 from natural uranium containing 0.7-percent U-235. [redacted]

that--about 300,000 SWU per year -- only enough to provide fueling for the Koeberg reactors (hence to achieve self-sufficiency) and have some excess capacity for export.-4- (We believe it is more likely that this excess was intended, in part, for making up losses caused by unscheduled plant shutdowns.) [redacted]

Almost at the time of Roux's statement, the senior UCOR plant manager for the semi-commercial plant stated that South Africa had planned to have a 1- to 3 million SWU annual capacity by the year 2000. But he further indicated that his country did not consider the UCOR process to be an economically attractive way to expand.

[redacted]





TABLE

CAPACITIES OF SELECTED HEAVY-WATER REACTORS

Reactor (Country)	Power Level in Megawatts (thermal/ electrical)	Heavy Water Charge metric tons	Comments
NRX Canada	40/0	17	heavy water moderated light water-cooled
CIRUS (India)	40/0	20	heavy water moderated light water-cooled
Agesta (Sweden)	65/10	72	heavy water moderated and cooled
CIRENE (Italy)	130/40	55	uses some low enriche uranium fuel
KANUPP (Pakistan)	457/137	136	heavy water moderated and cooled
Marviken (Sweden)	463/138	180	heavy water moderated light water-cooled
Fugen (Japan)	557/165	86	heavy water moderated light water-cooled, uses some low enriched uranium and plutonium fuel
Gentilly (Canada) CANDU-BLW-250	800/250	212	heavy water moderated light water-cooled
Atucha-I (Argentina)	1,100/340	300	heavy water moderated cooled
Pickering (Canada)	2,056/540	500	heavy water moderated and cooled

This table is unclassified.