MORI DocID: 651178

National Foreign Assessment Center

~~Top Secret~~

[redacted]

~~NOFORN-NOCONTRACT-PROPIN-ORCON~~

[redacted]

(b)(1)
(b)(3)
(T)

The South African Peaceful Nuclear Program: Its Dependence Upon Foreign Assistance

An Intelligence Assessment

APPROVED FOR RELEASE
DATE: SEP 2001

~~Top Secret~~

SI 79-10108J

[redacted]

November 1979

National
Foreign
Assessment
Center

Top Secret
[redacted] ONTRACT
PROPIN,ORCON

The South African Peaceful Nuclear Program: Its Dependence Upon Foreign Assistance [redacted]

An Intelligence Assessment

Information available as of 1 October 1979 has been used in the preparation of this report.

The author of this report is [redacted] Office of Scientific Intelligence. Contributions were provided by the Offices of Economic Research and Political Analysis. Comments and queries are welcome and should be directed to the [redacted] Office of Scientific Intelligence, [redacted]

This report was coordinated with the Office of Economic Research, the Office of Political Analysis, the Office of Imagery Analysis, the Directorate of Operations, and the National Intelligence Officers for Nuclear Proliferation and for Africa. [redacted]

Top Secret
SI 79-10108J
[redacted]

The South African Peaceful Nuclear Program: Its Dependence Upon Foreign Assistance [redacted]

Overview

The Republic of South Africa has based its peaceful nuclear program on assistance from Western governments, primarily those of the United States, the United Kingdom, and France. In recent years that assistance has been reduced to a level far below South Africa's expectations, and the South Africans consequently have taken steps to reduce their dependence upon foreign nuclear suppliers. This paper examines the status and likely course of the peaceful nuclear program and identifies the areas in which South Africa will continue to be dependent upon assistance from outside sources. [redacted]

The results are summarized in the table on page 11. Over the next five years South Africa probably will significantly reduce its present reliance upon foreign suppliers:

- Completion of the Koeberg nuclear power reactors, scheduled for the period 1983-84, will lessen South Africa's dependence upon France to the point where the fabrication of fuel elements for those reactors will be the principal remaining need. [redacted]
- Expansion of the Valindaba enrichment plant, scheduled to be completed in 1984, will permit South Africa to produce sufficient amounts of slightly enriched uranium to refuel power reactors—thus freeing it from dependence on the United States for enrichment services. [redacted]

[redacted]

Nevertheless, South Africa will remain dependent upon foreign suppliers to meet its long-range goal of constructing nuclear power stations in lieu of coal-fired power plants. The South Africans have indicated an interest in beginning several new nuclear power projects in the 1980s, although their government could easily afford to postpone further reactor construction for many years; widespread construction is not planned to begin until the 1990s. [redacted]

Contents

	Page
Overview	iii
Uranium Mining	1
Chemical Conversion of Natural Uranium	1
Uranium Enrichment	2
Valindaba Pilot Plant	2
Future Enrichment Plants	4
Nuclear Fuel Fabrication	5
Fuel for the Safari Research Reactor	5
Fuel for the Koeberg Power Reactors	6
Nuclear Power	7
Spent Fuel Reprocessing	8
Reactor Development	9
Peaceful Applications of Nuclear Explosives	10
Computational Capabilities	10

Table	
The Estimated Extent of South African Dependence Upon Foreign Supplies Through 1985	11

The South African Peaceful Nuclear Program: Its Dependence Upon Foreign Assistance [redacted]

Uranium Mining

South Africa probably will have adequate supplies of uranium for its own nuclear program for many decades. Its vast uranium deposits amount to perhaps 250,000 metric tons (mt) recoverable at about $66 or less per kilogram of uranium oxide concentrate (U_3O_8) [Reference 1], which formed the basis of the South African nuclear program. The desire to improve ore processing technology to compete with foreign uranium producers spurred the earliest South African research in the nuclear field, and sales of the resultant natural uranium concentrates have maintained South Africa as a leader in uranium exports. [redacted]

Higher prices for both gold and uranium in the past few years have led to a considerable expansion of uranium production. [2] Annual production in the past four years increased from about 2,900 mt in 1975 to about 4,500 mt in 1978; it is expected to exceed 6,000 mt in 1980. [2-4] [redacted]

In addition to the Rossing deposit currently being exploited in Namibia, in which South Africa has a small share, other Namibian deposits are being explored and mapped out for near-term development. The South Africans also are examining the possibility of similar uranium mining projects in the Karoo. [5] Preliminary investigations suggest that, if South Africa were to lose access to Namibian uranium, the mining of deposits northeast of Cape Town would permit the continued expansion of South African uranium production. [6] The Atomic Energy Board (AEB), which operates the Pelindaba nuclear research center near Pretoria, has opened a branch office in Beaufort West to support these investigations. [5] [redacted]

[redacted]

[redacted]

Chemical Conversion of Natural Uranium

Traditionally, South Africa has exported uranium in the form of a uranium oxide concentrate. Customers routinely made their own arrangements for conversion of the concentrate to uranium metal or dioxide for use in natural-uranium-fueled reactors or to uranium hexafluoride (UF_6) to use as feed for enrichment plants. Nevertheless, the Nuclear Fuels Corporation (NUFCOR), which markets South Africa's uranium concentrate, has long been capable of some further processing at its plant near Johannesburg. There uranium concentrates can be converted to uranium dioxide or uranium tetrafluoride (UF_4), and the UF_4 can be converted to uranium metal. The capacity of the NUFCOR uranium metal production facility probably is about 100 metric tons per year (mt/y). [10] [redacted]

The NUFCOR capacity for UF_6 production is not known, but it apparently exceeds by a considerable margin the requirements of the uranium enrichment program, which now amount to as much as 300 mt/y in terms of elemental uranium. [11] In addition to this capacity, another UF_6 production facility probably is nearing the commissioning phase at Pelindaba. The new facility was completed last year with process technology developed and tested by the AEB Process Metallurgy Division. It probably incorporates improvements in process control (digital monitoring and control techniques) rather than new or different chemical processes. The capacity of the new plant is stated to be 250 mt/y; it probably was designed to give South Africa a UF_4 production capacity adequate to meet the future needs of the domestic uranium enrichment facilities that are now being expanded. [12] [redacted]

Uranium hexafluoride (UF_6) feed material for the Valindaba enrichment plant is produced at Pelindaba in a plant that was designed and built with French assistance in 1974 and 1975. [13] The Minister of Mines announced the completion of this plant in 1975, stating that it was a commercial module with a capacity of 200 mt/y and was intended to be a basic unit of a large-scale UF_6 plant. [14] This confirms other statements that the plant was designed to provide experience directly applicable to the construction of a larger plant, but the cited capacity appears low. A capacity of 200 mt/y would be roughly equivalent to the amount of feed material needed annually for the existing enrichment plant at Valindaba, but two pieces of evidence suggest that the plant may in fact be somewhat larger: (1) The South Africans reportedly tried in 1975 to make arrangements for the sale of up to 500 tons of apparently surplus UF_6 over the period 1977-78, [15] [redacted] It could be that the announced capacity refers to operation of the plant for only eight hours per day while actual plans may have been based on greater utilization. [redacted]

Production of UF_6 at the Pelindaba plant has been limited by technical problems. Equipment failures and gaseous and liquid leaks in the plant caused it to be shut down for about six months in 1977. [16] The AEB Annual Report for 1978 states that these problems have been solved. The plant, nevertheless, appears to have been idle for several months last year because of a shortage of imported hydrofluoric acid. There are several producers of fluorine in South Africa, and the AEB itself is working to develop improved fluorine production technology. [16] It is unlikely, therefore, that the South Africans regard the importation of hydrofluoric acid as a critical long-term dependence. [redacted]

The Uranium Enrichment Corporation (UCOR) is to incorporate the technology and experience gained in the construction and operation of the pilot UF_6 plant to build a new facility at Valindaba. [12] Having acquired most of the technology for UF_6 production from France and having mastered the operation of the pilot plant, South Africa probably is capable of expanding its UF_6 production capacity without further assistance. [redacted]

Uranium Enrichment

Valindaba Pilot Plant

The uranium enrichment plant at Valindaba, adjacent to the Pelindaba nuclear center, is believed to have been built to produce either reactor-grade or weapons-grade uranium.[1] It was constructed almost entirely by domestic industry and is not covered by any nonproliferation safeguards agreements. It is likely that the Valindaba plant has produced limited amounts of both slightly enriched and highly enriched uranium since its faltering startup in 1975. [redacted]

Operating smoothly in the low-enrichment mode, the plant probably could produce about 25 tons of reactor-grade uranium per year (at about 3.2-percent uranium-235). This would be adequate to meet the annual fuel requirements of one of the two power reactors purchased from France and now under construction at Koeberg, near Cape Town. It is unlikely, however, that South Africa ever intended to rely on the inefficient Valindaba plant to meet the enriched uranium requirements of domestic power reactors. In 1974 South Africa signed a contract with the United States to obtain the enrichment services needed for the Koeberg reactors. At that time the South Africans expected to rely on US enrichment services until a domestic commercial enrichment plant could be put into operation in the mid-1980s. In part because of subsequent US requirements that South Africa revise its nuclear policy and sign the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), however, and also because of political difficulties in importing sophisticated technology for the future commercial uranium enrichment project, [17] South Africa decided in late 1977 to undertake a rapid expansion of the Valindaba plant with the goal of

[redacted]

meeting domestic enrichment needs indigenously at the earliest opportunity. [18] [redacted]

[redacted] The new facilities are scheduled for completion in 1984, and partial operation is unlikely to contribute to the overall Valindaba capacity before 1982. [redacted]

The estimated design capacity of the existing plant at Valindaba is such that the South Africans, starting about now, could stockpile sufficient material in time for the fabrication of an initial core load of fuel for the Koeberg reactors by 1982. This could allow startup of the first reactor on schedule at the end of 1982. If the existing plant capacity were then dedicated to maintaining the operation of the first reactor, the production of enriched uranium to fuel the second reactor would have to await startup of the new enrichment facilities, probably causing a delay of about two years beyond the startup of this second reactor scheduled at the end of 1983. Alternatively, enriched uranium could be stockpiled to start up both reactors more or less on schedule, after which the reactors could be operated at reduced power levels (about half capacity) for the first two years to conserve fuel until the expanded enrichment plant could be brought on line. [redacted]

The latter contingency plan appears quite reasonable, because past experience suggests that the Koeberg reactors would operate at reduced power for the initial year or so in any case. It must be stressed, however, that the Valindaba plant has a history of operational problems, it is expensive to operate, and the South Africans would have to give up the production of highly enriched uranium at Valindaba for the next three to five years. Together these facts constitute a compelling reason to seek an external source of enrichment services. In fact, South Africa recently let it be known in European circles that it wants to purchase the necessary enrichment services, though the specific enrichment requested would be adequate only for fabrication of the initial coreloads of fuel. [21]

The South Africans thus may plan to use the Valindaba plant only to meet the subsequent refueling requirements of the two reactors. A prolonged reduction in power may also be planned to conserve the initial fuel. [redacted]

The foreign enrichment services needed to permit timely and unrestricted operation of the Koeberg reactors probably could be secured from only a few sources, other than the United States. The Soviet Union is a possible source but for political reasons almost certainly would not provide such assistance to the South African nuclear program. Urenco enrichment services probably will not be available because of the involvement of the Dutch Government, whose agonizing over participation in the Koeberg construction project moved the South Africans to award the contract to the French. The French have decided not to supply enrichment for Koeberg in place of the United States, even though they are building the reactors and fabricating the necessary fuel. [22] The most likely sources are the minor partners of the French-led Eurodif enrichment consortium. Italy, Spain, and Belgium are facing the costly burden of an oversupply of enriched uranium from their shares of the Eurodif enrichment operations, aggravated by the probable withdrawal of Iran from the enterprise, which would require one or more partners to absorb the Iranian share as well. [redacted]

If South Africa fails to find an alternative foreign source of enrichment services, the government will be forced to weigh the political and military consequences of ratification of the NPT against reduced or delayed operation of the Koeberg reactors. A review of the South African energy supply and demand situation indicates that even a two- or three-year delay in operating the Koeberg power station would have only a small impact on the overall ability of the Electricity Supply Commission (ESCOM) to meet the projected electricity demand and that the associated economic impact would be reflected primarily in a small increase in power costs for consumers during those years. Judging by the government's willingness to increase significantly the cost of gasoline to help finance development of alternatives to imported oil, the economic consequences of a temporary delay in starting the Koeberg reactors probably would not be sufficiently serious to provide much leverage for influencing South African nuclear policy. In the event that the French complete the Koeberg reactors but refuse to fabricate the necessary fuel unless the US demands are met, the economic loss would, of course, be much greater. [redacted]

Future Enrichment Plants

As noted earlier, UCOR originally planned to build a large commercial uranium enrichment plant. South Africa planned to add to its foreign exchange earnings by exporting its uranium in an enriched form. Even though gradual cutbacks in nuclear power programs around the world threatened to cause a surplus of uranium enrichment capacity in the mid-1980s, South Africa, nevertheless, was preparing to proceed with the construction of a plant that would correspond to about 10 percent of the world's commercial enrichment capacity at that time. [23] The South Africans probably were confident that their position as a vendor of enriched uranium, rather than as a mere supplier of enrichment services, would give them a clear advantage in the enrichment market. As a leading producer of natural uranium—a commodity in greater demand than enrichment services—South Africa believed it would be in a position to require that its customers purchase some or all of its uranium in an enriched form. In fact, NUFCOR had already begun to include such clauses in new uranium sales contracts before the commercial enrichment venture was deferred. [24] Since then, increasingly restrictive export controls placed on uranium (and enrichment services) by other major suppliers have put South Africa in a more advantageous position from the point of view of safeguards. [25] [redacted]

The single greatest reason for postponing the construction of a commercial enrichment plant was the inability of UCOR to obtain the axial flow compressors necessary for the commercial exploitation of its clever "helikon cascading technique." This technique, which would limit capital costs by permitting several process gas streams to be pumped by a single axial-flow compressor, probably has been tested only in a few prototype units. Because South African industry is not capable of supplying the necessary axial-flow compressors at a reasonable cost and because US companies have not been permitted to export compressors for such projects, UCOR hoped to find West European firms that could fill this critical gap. [26] By the end of 1977 UCOR apparently decided that the chances of finding a willing vendor and getting the equipment to South Africa were not sufficient to justify launching the commercial project. [17] [redacted]

According to announcements made in early 1978, South Africa will take into consideration the prevailing "economic" conditions and reconsider the construction of a commercial enrichment plant after the interim expansion of Valindaba is finished. [27] If South African industry is still unable to produce axial-flow compressors for UCOR at that time, Pretoria will again be dependent upon foreign assistance to undertake this project, which has been estimated to be worth $600 million per year in foreign exchange earnings. The South Africans thus may well be continuing their contacts with European compressor manufactures in an effort to obtain production technology despite the postponement of a commercial project. Without foreign assistance, South Africa probably would not be able to launch the commercial enrichment project before about 1990. [redacted]

[redacted]

It is possible, though not likely, that South Africa has succeeded in acquiring a modest number of axial flow compressors—in addition to the several reported to be in use in the research and development program [32]—perhaps through discreet purchases such as the one reported by *Der Spiegel* in 1977.[2] [33] If so, the helikon cascade technique could be tested and proved in the expansion project now under way. [redacted]

One important piece of equipment that may not be obtainable abroad is a process monitoring and control computer. The existing control unit at Valindaba was obtained from a US company, but further acquisitions from the same source are not likely. South Africa's plans in this area are not known. The existing computer at Valindaba may be adequate to meet the new demand, or the Instrumentation Division of the AEB may be tasked to expand its capabilities. [redacted]

Nuclear Fuel Fabrication

Fuel for the Safari Research Reactor

The AEB began to perfect the technique of fabricating fuel elements for the Safari research reactor at Pelindaba in the late 1960s. At least one fuel element was manufactured—essentially an exact duplicate of the imported fuel but made with natural uranium rather than highly enriched uranium. [36] In early 1978 South Africa no longer had confidence in overseas sources of supply, and the Valindaba enrichment plant was capable of producing moderately high enrichment levels. [37] [redacted] South Africa had made "a firm decision in principle to equip itself to produce Safari fuel" and cited metallurgical studies that had led to the fabrication of fuel plates with a high ratio of uranium to aluminum. The goal was to produce fuel at a reduced enrichment level; the work was said to be preliminary in nature. [38] [redacted]

[redacted] the AEB was planning to produce a core load of Safari fuel by the end of 1978, [39] and a special building was constructed at Pelindaba for the project. [40] The enrichment level chosen for the fuel was 32 percent. [41] The new fuel was intended to be placed in the reactor by June 1979. [42] Subsequent delays apparently have been due to a desire on the part of the South African Government to avoid the repercussions that might follow the disclosure of a capability to produce weapons-grade uranium; such a disclosure would be almost inevitable if domestically produced fuel were used in the Safari reactor.[3] Earlier this year the AEB apparently submitted the question of using its own fuel to the government for a policy decision, which was scheduled to be made by the end of June. [43] Perhaps as a result, when Dr. A. J. A. Roux retired as AEB president at the end of June, media interviews with him and with his successor occasioned extensive discussion of South African dependence upon the United States for nuclear fuel. The resultant quotations and editorials indicated that no decisions had been reached concerning the best way to address South Africa's domestic capabilities. Rather, conflicting statements were issued asserting that "South Africa has the technology to produce highly enriched uranium, but no actual plant is planned," [44] and that the existing plant at Valindaba—with extensions now under way and some modification—could produce uranium for both Safari and Koeberg fuel within three years. [45] [redacted]

The latter statement is the most recent and appears to have been more carefully constructed than previous remarks. Of some interest is the optimistic implication that the expansion of Valindaba will have progressed sufficiently in three years to support the Koeberg reactors at their intended power levels. This issue is discussed above. More important, the statement is the only assertion that South African facilities will be able to produce highly enriched uranium (even though some "modification" is involved). It may be that in

[3] Under a safeguards agreement, the reactor is inspected by the International Atomic Energy Agency three to four times per year, and South Africa would be obliged to notify the Agency of the use of domestically produced fuel. Clandestine operation would be possible but hardly worth the risks. [redacted]

making this statement the South African Government was preparing for the eventual overt use of domestically produced Safari fuel—attributing this capability to future facilities and thereby avoiding the need to acknowledge that such a capability has existed all along. The reference to three years from now is consistent with the time when additional enrichment stages may begin to be installed and operated in the new facility. It may also be that a decision was made not to demonstrate any capability to produce weapons-grade uranium until construction of the Koeberg reactors has been essentially completed, which is to be about three years from now. Totally reliant upon the French industry to build this nuclear power station, the South Africans probably are concerned that overt production of Safari fuel could bring sufficient pressure upon the French Government to halt the project or to make its completion contingent upon the same nonproliferation requirements that the US Government has set forth. [redacted]

One can argue that until South Africa is willing to use domestically produced fuel for the Safari, the capability to produce this fuel will not reduce South African dependence on the United States in this area. It must be noted, of course, that a government decision not to use domestic fuel may indicate a low current priority on operation of the Safari reactor as well as concern over possible related repercussions. At present few important research projects make use of the Safari reactor, in part because of the cancellation of projects two years ago when the reactor operation was severely reduced to conserve US-supplied fuel. The remaining projects likely to be of some importance are the production of radioactive isotopes for industry and medicine (which can be carried out at reduced power levels and supplemented with purchases abroad) and irradiation testing of materials in the power reactor fuel development effort (which would require operation of the Safari reactor at high power levels). While Dr. Roux has hinted that the Safari would be refueled within three years, this time frame might correspond to a delay of up to three years in developing a domestic capability to manufacture fuel for the Koeberg reactors. [redacted]

Fuel for the Koeberg Power Reactors

The indigenous development of the technology required to produce fuel for the Koeberg power reactors near Cape Town would take more time and effort than was necessary to master the production of Safari fuel. The high endurance and low failure rate required of power reactor fuel and the use of this fuel in a facility that is much more important than the Safari reactor, in terms of economics and safety requirements, led South Africa to seek proven foreign technology from the outset. [46] When France was awarded the contract to construct the reactors at Koeberg, discussions began on the purchase of a license to manufacture the necessary fuel in South Africa. The license agreement, under which the French firm [4] manufactures the fuel, prohibited the transfer of the fabrication technology, however, and the South Africans turned to [redacted] in the United States for assistance. The discussions with [redacted] never proceeded beyond the exploratory phase. [47] [redacted]

[redacted]

[4] Societe Franco-Belge de Fabrication de Combustibles (FBFC) is to produce the initial core load and five reloads of fuel for each of the Koeberg reactors. [48] [redacted]

[redacted]

The speed with which a domestic fuel fabrication capability can be established will depend on the assistance obtained abroad. Aside from the unspecified lectures and discussions, the extent of that assistance has not been reported. With unlimited assistance, South Africa probably could be in a position to begin manufacturing Koeberg fuel elements by the end of 1981. Without proven technology for sintering uranium dioxide pellets and for forming, machining, and welding zirconium components, South Africa might easily spend five years reiterating small-scale irradiation tests of materials and fabrication techniques before adequate fuel performance and safety can be assured. Construction of a fuel fabrication plant probably would add an additional two or three years. Without assistance, therefore, South Africa cannot expect to be ready to fabricate Koeberg fuel upon completion in 1984 of the expansion of the Valindaba enrichment plant. [redacted]

In addition to the production of the enriched uranium dioxide necessary for domestic fuel fabrication, South Africa must produce or purchase the zirconium alloy that forms the structure of the fuel elements. As of early 1978 the AEB reportedly was encountering difficulties in attempting to acquire zircaloy tubing (used as cladding material). Further, given the limited number of sources of this material, an independent fuel production capability may well require the domestic production of the zirconium itself. [52] South Africa has known deposits of zirconium ore; zircon sands along the northeast coast have been processed for years, and zirconium oxide has been recovered as a byproduct of copper and phosphate production. [53, 12] The problem for fuel manufacturers is to obtain refined zirconium of sufficient purity.[3] Since late 1977 the AEB and National Institute for Metallurgy have been making use of an electron-beam furnace to produce small amounts of nuclear-grade zirconium in a new refinement process under development. [54] Presumably, South Africa plans to produce nuclear-grade zirconium on a large scale if the process is successful. (In the event of unforeseen obstacles, of course, a conventional refinement process could be employed.) [redacted]

[3] Naturally occurring impurities (hafnium in particular) absorb neutrons and thereby impede the desired fission process in the fuel. [redacted]

Nuclear Power

One of South Africa's long-term goals is to substitute nuclear power reactors for coal-fired power plants, thus extending its domestic energy resources. The widespread construction of nuclear power stations is not planned to begin until the 1990s, however. [55] The South Africans have estimated that by the turn of the century coal reserves and mining operations will reach the point at which economically advantageous coal supplies no longer can be guaranteed to cover the 25-year lifetime of new coal-fired plants.[4] Figures mentioned for total nuclear power generating capacity installed by the year 2000 have ranged from 7,000 to 20,000 megawatts. [56] These figures do not reflect firm long-range plans, however. Rather the South Africans have been taking a step-by-step approach to meeting this long term goal [redacted]

When the decision was made to build a nuclear power station at Koeberg it was expected that a single 950-megawatt power plant would be needed in full operation in the area during the second quarter of 1983. [55] Lacking this, power would have to be conveyed to the Cape area from the northeast by high voltage transmission lines, or coal would have to be transported from the northeast to fuel additional conventional plants—alternatives that have been debated by ESCOM, the AEB, and others. The AEB reportedly prevailed over opponents to the nuclear alternative. [57] Shortly thereafter, ESCOM began preparations for the construction of an additional 3,600-megawatt coal-fired plant in the northeast, [58] which would constitute an expected surplus of capacity for that area (well above the 17-percent reserve capacity that ESCOM normally maintains). [55] It may be that ESCOM, in its cautious approach to the matching of supply to anticipated demand, wanted a

[4] Recent upward revisions of South Africa's coal reserves may delay widespread construction until the next century. [redacted]

hedge against technical delays in getting the nuclear reactors into operation. Since then, the growth in electricity consumption has been less than predicted, particularly during the slight recession of 1977. [59] As a result, it appears likely that the overall South African power generating capacity will be adequate even if the contribution of the Koeberg reactors is delayed by two to three years. The need to move up construction of a $300 million transmission line [55] and the need to buy and burn more coal than expected for the power plants in the northeast probably would pose few technical or engineering problems. It would increase the cost of electricity for consumers, but ESCOM probably would take this relatively small economic penalty in stride. [redacted]

Plans for the construction of additional nuclear power reactors have been subject to continual revision. [redacted]

Commitment to a new nuclear power project would be persuasive evidence that South Africa does not expect any further deterioration in its image as a buyer in the nuclear market. South African industry is a decade away from the point where it can begin to make a significant contribution to the construction of nuclear power reactors; an independent power reactor industry is very far off. Thus, during the period between a request for bids and the completion of a new nuclear power plant, the South African Government almost certainly would not intentionally reveal evidence of a nuclear weapons program (such as probably would result from a nuclear test). Conversely, if the South Africans were to plan an overt or easily detected action that could provide direct evidence of nuclear weapons development, it is unlikely that they would simultaneously place a new billion-dollar reactor project at risk. [redacted]

Because the economic arguments for and against additional reactor construction can be expected to continue to shift, the decision to purchase more nuclear power stations probably will be made on other grounds, giving greater emphasis to politics or national security. Therefore, as long as the costs of coal and other economic factors continue to put nuclear power plants in roughly the same economic position as coal-fired plants, the government's desire to save South African coal for conversion to synthetic fuels and for export probably will be the deciding factor in support of nuclear power reactor construction. Depending on the South African perception of the need for an independent fuel fabrication capability, and hence possibly depending on the time required to establish such a capability, the construction of an additional nuclear power plant probably would be scheduled for completion in the late 1980s. [redacted]

Spent Fuel Reprocessing

South Africa has devoted little attention to the so-called *back end* of the nuclear fuel cycle—the reprocessing of irradiated fuel elements to separate plutonium and unused uranium from radioactive fission products and the storage or disposal of the resultant radioactive waste. The present resources of the AEB probably are not adequate to support both a high priority fuel fabrication project and an effective fuel reprocessing development effort. Although research that could be applicable to fuel reprocessing has been done by the AEB for years, the choke point in such projects at Pelindaba is the availability of engineers and engineering services, needed to move from laboratory results to large-scale experiments and pilot tests. Nuclear fuel reprocessing research per se probably does not enjoy sufficient priority to draw more than sporadic assistance from the machine shops, draftsmen, and engineers who divide their time among the projects that are intended for near-term application. [redacted]

Fuel reprocessing facilities will not be needed to service the South African power reactors before the turn of the century. A reprocessing facility will be useful in the 1980s only if the South Africans want to produce plutonium—an unlikely case—or if they decide to use domestically produced Safari reactor fuel for an extended period. In the latter case, the value of the enriched uranium contained in the accumulating spent fuel elements could help to justify the construction of a small pilot reprocessing facility (capable of handling perhaps half a kilogram of spent fuel per day). [redacted]

[redacted]

Reactor Development

More likely than construction of a fuel reprocessing facility, as the next major AEB project, is the construction of an experimental nuclear reactor. An indigenously developed reactor probably would be designed either to supplement the Safari facilities for testing fuel designs applicable to conventional light-water reactors or to permit experiments on a new type of reactor system. The Reactor Development Divison of the AEB, which apparently has been conducting a modest amount of research on advanced fast reactors since the late 1960s, may well have reached the point in its computer modeling studies where further progress is hampered by a lack of suitable test facilities. Dr. J. W. L. de Villiers, the recently appointed president of the AEB, stated [redacted] in mid-1978 that he hoped to install at the RDD complex [64]—probably using the same facilities employed in the nuclear weapons program—a fast critical assembly (zero power reactor), [64] which would be used to check the computer models. The logical follow-on to this experimental device would be a small fast reactor, having a thermal power rating of several tens of megawatts. [redacted]

The most likely advanced reactor systems for development by South Africa are the sodium-cooled and molten-salt fast breeder reactors, both of which seem to have been considered by the AEB. The fact that such systems are already under development by more advanced groups in other countries means South Africa almost certainly will not be at the forefront of the technology development. An indigenous program, however, would greatly assist in the assimilation of foreign technological advancements or in the later introduction of foreign commercial systems. [redacted]

[redacted]

A precedent for this kind of approach to project planning is evident in the establishment of a Tokamak facility in the Physics Division of the AEB. This facility was set up to permit plasma physics research in the field of nuclear fusion, which is decades away from commercial exploitation. [65] Although the AEB rarely undertakes projects with so little promise of direct applications, such a project was determined to be necessary for the preservation and expansion of expertise in nuclear physics. [redacted]

~~Top Secret~~
[redacted]

Peaceful Applications of Nuclear Explosives

[redacted]

Computational Capabilities

A brief mention of AEB computational capabilities is warranted; this is an area in which the South Africans are seeking foreign assistance. A new AEB division—the Computational Sciences Division—was established at Pelindaba last year to ensure the most effective use of the existing computer, an IBM 370/155. [69] This computer is considered inadequate for the present demands, however. Dr. DeVilliers has stated that a more advanced computer is one of the AEB's greatest needs, [70] and such an item would necessarily have to be imported. The acquisition of new computer facilities (an IBM 3033 and an advanced Japanese computer have been considered) is hampered by export restrictions. [71] The South African Government has not indicated any willingness to make political concessions in order to obtain such facilities for the AEB.

[redacted]

The Estimated Extent of South African Dependence Upon Foreign Suppliers Through 1985

Program Requirement	Probable Importance to South African Government	Estimated Degree of Dependence 1977	78	79	80	81	82	83	84	85	Supplier	Comments
Uranium Production	High											South Africa will remain technically self-sufficient but will welcome financial investment.
Uranium Conversion	High											Indigenous capabilities have replaced earlier dependence upon French technical assistance.
Uranium Enrichment Services for Power Reactor Fuel	Medium										United States	Replacement of US services with domestic production would preclude extensive stockpiling of highly enriched uranium until about 1984.
Construction of New Enrichment Facilities at the Valindaba Site	High										Multiple	Foreign equipment to be used in the plant probably already is being manufactured and delivered.
Construction of a Commercial Uranium Enrichment Plant	Medium										Multiple	The timing of the project has not been decided. Such a decision is to be made following the completion of the Valindaba expansion.
Production of Highly Enriched Uranium for Research Reactor Fuel	Low-Medium										United States	Despite the domestic enrichment capability, South Africa has not exploited that capability to support production of research reactor fuel (see page 5).
Fabrication of Fuel Elements for the Safari Research Reactor	Low-Medium											Suitable technology is either available or under development.
Fabrication of Fuel Elements for Power Reactors	High										France	South Africa is attempting to establish a domestic capability, but the timing of such a capability will be dependent upon access to foreign technology.
Completion and Startup of the Two Koeberg Power Reactors	High										France	South Africa is totally dependent upon foreign suppliers for construction of nuclear power plants, and some assistance is required during the initial year of operation.
Additional Power Reactors	Medium										Undetermined	The timing for a new project is uncertain. It is likely that a new billion-dollar reactor will be ordered only if South Africa feels assured of continued foreign assistance to complete the project.
Reprocessing of Spent Nuclear Fuel	Negligible-Low										United States, France	Research reactor fuel (for the Safari) now is reprocessed in the United States; power plant fuel (for Koeberg) must be reprocessed outside South Africa.
Reactor Technology Development	Negligible-Low											For the near future, South Africa probably will maintain a limited technology development effort, without reliance on foreign inputs.
Peaceful Applications of Nuclear Explosives	Negligible											Political considerations and the absence of a clear need preclude the use of a peaceful nuclear explosion, though the South African Government has sought to preserve the option.

High — Medium — Low — Negligible

~~This table is Secret Noforn Nocontract Orcon.~~