NEWS AND COMMENT

Uranium Enrichment: With Help, South Africa Is Progressing

A few weeks ago Congressman Les Aspin, the Wisconsin Democrat who has made a reputation for ferreting out horrifying examples of slipshod management in government, scolded the Ford Administration for, of all things, selling weapons-grade uranium to South Africa. Aspin acknowledged that the 100 pounds of highly enriched uranium stockpiled by South Africa and added amounts to be sent in 1975 were destined to fuel South Africa's lone, small research reactor. But he said it was enough to make a number of nuclear weapons.

"South Africa has the fear to want to build a bomb and it has the technical skill," Aspin charged in a press release. "All it needs is weapons-grade uranium, and the U.S. government is now supplying that."

Aspin's point—that the U.S. government needs to be more careful about where it sells nuclear fuel—is hard to contest. Holding South Africa up as an example, however, seems faintly ludicrous. In the not-so-distant future South Africa is going to need American enriched uranium about as much as Kuwait needs American oil.

It has been 5 years since Prime Minister John Vorster announced, to the accompaniment of worldwide skepticism, that South Africa had developed a "unique" and "competitive" new process for enriching uranium. In July 1970 A. J. A. Roux, the president of South Africa's Atomic Energy Board, heightened the suspense by adding that the process was "a phenomenal achievement of world dimension.... It is an entirely new principle. And we have thought it out and worked it out ourselves—every calculation and every little step in the process.... It is all the work of South Africans."

To many at the time these seemed outlandish assertions from a nation whose nuclear program was best described as competent but drowsy. A shroud of secrecy around the mysterious new process did nothing to enhance South African credibility in the matter.

But now the scoffing has largely stopped, and American enrichment experts are taking South Africa more seriously. The phenomenal new process turns out to be less unique than advertised, and in fact bears a strong family resemblance to the "nozzle" enrichment technology being developed by West Germany (*Science*, 30 May). But with a little help during the past 2 years from the same German researchers who are proposing to help Brazil obtain nozzle enrichment know-how, South Africa's own project appears to be moving along right on schedule. Last April, AEB officials said a pilot enrichment plant located near Pretoria had gone into full operation. And in recent weeks Roux and others have declared South Africa's intention to build a $1.3 billion commercial-scale enrichment plant by 1984 with or without foreign financial help.

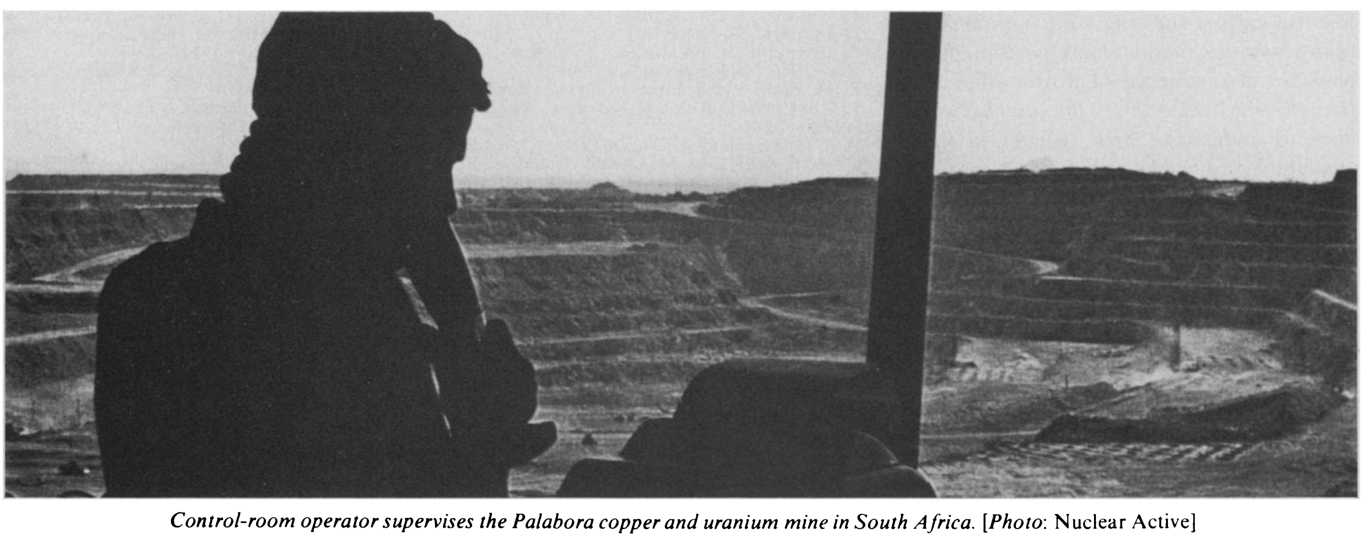
South Africa's uranium resources, available mainly as a by-product of gold mining, are very large. The most recent official estimates place "reasonably assured reserves" of uranium oxide, recoverable up to $10 a pound at 300,000 short tons, only slightly less than proven reserves in the United States. A portion of this—how much is hard to say—consists of low-grade ores in South West Africa or Namibia, to which South Africa is under stiff United Nations pressure to grant independence. The possible loss of Namibian uranium, however, could be offset by new discoveries in the Karoo sedimentary formations that cover 40 percent of South Africa. Exploration by the South African affiliate of the Union Carbide Corporation during the past 4 years has revealed deposits resembling the rich uranium belt of the Colorado Plateau.

Thus it seems probable that South Africa will be able not only to satisfy its own needs for uranium fuel but also to lay claim to part of the vast global enrichment market expected to materialize in the 1980's.

This new capability is plainly pregnant with strategic implications, although the South Africans insist they have only peaceful, commercial intentions—to earn upward of $375 million a year in foreign exchange from uranium by marketing it in processed, not raw, form. Further, the Vorster government has consistently and strenuously denied any intention of building nuclear weapons. (Embassy officials in Washington also resent Aspin's implication that the AEB might divert some of the American-supplied reactor fuel for explosives. "We live up to our international commitments," said one official, emphasizing the "We.")

Questions of integrity aside, however, South Africa's continuing, though low-key, interest in "peaceful" nuclear explosives, its disinclination to sign the 1970 Non-Proliferation Treaty, and the growing political isolation of Pretoria's white-minority rule would all seem to give substance to the possibility of a future change of heart toward nuclear weaponry.

Over the past 5 years South Africa's



Control-room operator supervises the Palabora copper and uranium mine in South Africa. [*Photo*: Nuclear Active] mysterious enrichment process and its uncertain nuclear intentions have lent an extra touch of intrigue to the international energy scene. The Vorster government has nurtured the mystery with a delicate touch, it being second only to heart transplantation as a source of national scientific prestige. From time to time the AEB's attractive publication *Nuclear Active* would drop a hint that the pilot plant was coming along quite well, and once it printed a conspicuously fuzzy picture of the plant—a nondescript cluster of concrete buildings marked by a row of smokestacks. The government also disclosed that the plant was located near Pretoria at a site called Valindaba, a Bantu word that means "This we do not talk about."

But lately South African officials have been talking more about their plant. The most recent occasion was the European Nuclear Society conference in Paris in late April, where AEB president Roux said he intended to "lift the curtain somewhat." Roux's speech fell short of the now-it-can-be-told class, but he did provide a tantalizing glimpse.

He and W. L. Grant, who is credited with having invented the process, called it a "high performance stationary-walled centrifuge," a term they left largely unexplained. What it apparently means is that a high-speed stream of gas—a mixture of uranium hexafluoride and hydrogen—flows along a path that allows centrifugal force to separate the heavier uranium-238 from the fissionable uranium-235. This approach dispenses with the troublesome high-speed rotors of conventional gas centrifuges, hence the term "stationary-walled." The process is less energy-efficient than the two now in commercial use—gaseous diffusion and the gas centrifuge—but South African officials say their process requires fewer stages and simpler technology than the other two, and thus runs about one-third the cost of other processes. (This apparently assumes, however, that electricity from coal or hydroelectric dams is relatively cheap, as it is in South Africa.)

To American enrichment experts, all this sounds strikingly like the jet-nozzle enrichment process developed over the past 20 years by Erwin-Willy Becker at West Germany's Karlsruhe Nucear Center. Becker, in fact, sometimes describes his technique as a stationary-walled centrifuge, in which a sheet of uranium gas flows through a slitlike nozzle and along a curving path. One big difference, however, appears to stem from what the South Africans call their "helikon" technique,* whereby the number of succesive stages for enriching uranium can be reduced to about 100—in comparison to thousands of stages used in gaseous diffusion and hundreds for the gas centrifuge and for Becker's process.

In spite of this difference, the Roux and Grant speech was notably devoid of claims that the process was wholly and uniquely South African.

Research began in 1961 and has thus far cost $148 million. Without mentioning any names, Roux and Grant said things were sufficiently advanced 2 years ago "to consider sharing some of our know-how with the outside world and in this way to test the feasibility of our process with foreign experts." Almost certainly this was a reference to the relation South Africa struck up in 1973 with Becker and with STEAG, AG, the large energy firm in Essen which is carrying Becker's nozzle process toward commercial development. Some U.S. analysts believe Becker and STEAG have helped the South Africans over some technical rough spots in scaling up their process and estimating its cost; the frequent presence of South Africans in Karlsruhe had fueled speculation that the two nations' processes were similar, and that speculation now seems confirmed.

The next major development may be the announcement in the next few months of an international partnership to build a commercial plant based on the South African process. Roux and Grant disclosed that negotiations with "interested foreign parties" are now under way and in some cases are at an "advanced stage."

Just who these interested parties might be is, as ever, open to speculation. One U.S. analyst says relations with STEAG were "pretty close for a while," but are now unclear. The STEAG group would be a logical helpmate, but it is also a potential competitor, having all but concluded a deal with Brazil's military government to sell a nozzle enrichment plant. Coincidentally, South Africa has been strengthening its commercial ties with Brazil, and there are indications that talks have touched on an enrichment partnership. British and Japanese nuclear officials deny that they're among the "interested parties"; but France, Australia, and Canada are speculative possibilities.

Even if South Africa fails to come to terms with foreign participants, Roux and Grant concluded, it is almost certain that it will proceed to build an enrichment plant of 5000 tons capacity, roughly a third that of the United States. By the mid-1980's that may be only enough to satisfy 10 percent or less of the world's enrichment demand. But it will be more than enough to make South Africa a military nuclear power if it so chooses.

—ROBERT GILLETTE

*Somewhat cryptically described as being "based on the principle that an axial flow compressor can simultaneously transmit several streams of [gas] of different isotopic composition without there being significant mixing between them."

NIH Training Grants: The Uncertainty Factor

The research training programs of the National Institutes of Health (NIH) have been the cause of an annual brush between Congress and the Administration and a perennial source of anxiety and confusion to the biomedical research community.

Although there was some skirmishing late in the Johnson Administration, the advent of the Nixon Administration marked the beginning of a serious attempt by the Executive Branch to reduce the scale and alter the form of federal support of graduate and postgraduate training in the sciences. The main target was the training grant, which provides institutions with funds to conduct predoctoral and postdoctoral training programs, rather than the fellowship, which is awarded to individuals. The Administration was rather successful in squelching the training-grant in other agencies—the National Science Foundation's traineeships were wiped out—but Congress defended NIH's authority to award training grants and regularly provided funds absent from the budgets submitted by Presidents Nixon and Ford.

The biggest year for the NIH training programs was 1969, when a total of about $168 million was spent—about $139 million on training grants and $29 million on fellowships. In that year, the funds supported training for a total of 16,600 "full-time equivalent" people. Comparable figures for the most recent year in which awards were made—fiscal year 1974—are