# Chapter 11 Ensuring Against Reversal

After South Africa dismantled its nuclear weapons program, it retained the capability and knowledge to resurrect it. It had many hundreds of kilograms of weapons-grade uranium, and its experts had the knowledge and expertise to turn this material into nuclear weapons despite many of the documents and other records being destroyed. In addition, South Africa had established several sophisticated technologies and capabilities in its civilian industrial sector that could also be used to develop and produce nuclear weapons, if a decision was made to do so.[1]

The leaders of the nuclear programs were well aware of this residual capability and the suspicion that remained in the international community about their or a future government's intentions. To build confidence that South Africa would not build nuclear weapons, the government allowed several transparency steps that would make reconstitution of nuclear weapons more time consuming and subject to detection. However, countries such as the United States wanted South Africa to do more. It did some of these steps, despite their cost. Yet it resisted others, in particular eliminating its HEU stocks, which will be discussed in the next chapter.

## Additional International Verification Measures

One of the first priorities was ensuring that the nuclear weapons program had been thoroughly dismantled. Based on a new mandate to more thoroughly investigate nuclear programs following its failure to detect Iraq's large-scale nuclear weapons effort prior to 1991, the International Atomic Energy Agency (IAEA) undertook a number of initiatives specifically related to nuclear weapons to hinder the recreation of the nuclear weapons program. These steps went beyond the dismantlement steps ordered by the de Klerk government and the practices of traditional safeguards.

One of the IAEA's key steps after President de Klerk's March announcement was to focus on the destruction of remaining nuclear weapons components, blueprints, and documents.[2] By March 1993, when de Klerk revealed the past nuclear arsenal, many nuclear weapons-related items had not been destroyed. Armscor considered these items non-sensitive, but upon examination, the IAEA had a stricter definition of a sensitive item.

The inspectors discovered many of these items in the Circle or Advena storage rooms as they toured these sites under South Africa's expanded transparency policy. The risk of diversion of these items had been minimized because these storage areas had remained classified even after the commercialization of Advena in the early 1990s.

The inspectors inventoried the contents of the storage rooms and other areas in the plants then segregated items into three categories. The first and most sensitive category included items that could reveal significant dimensions or the design of the nuclear material core of the weapons. Examples of such items included tungsten reflector segments, mock-ups, and drawings and

[1] Tielman de Waal, "South Africa's Past Nuclear Program," Paper presented at a press briefing in South Africa, April 6, 1995, p. 6.

[2] Report by the Director General, IAEA. *The Denuclearization of Africa (GC(XXXVI/RES/557),* GC(XXXVII/1075), September 9, 1993, pp. 8-9.

photos of key components. The second category included components, such as the gun barrel and computer-controlled electronic boards, that would simplify the engineering design or reveal dimensions of other sensitive components. The reason that the gun barrel was in the second category is probably related to the fact that earlier, during dismantlement, Armscor had cut off what it called the "shoulder" of the gun barrel, rendering it, in its eyes, unusable in a nuclear device. The third category was everything else, such as motors, brackets, and cables, which the IAEA did not consider sensitive.

After inventorying the leftover goods, the inspectors recommended the complete destruction of any remaining components, photographs, and drawings which could reveal critical design information for nuclear weapons and their components. South Africa destroyed items in the first two categories. If an inspector had a serious concern about an item in the third category, it was also destroyed. The IAEA defined "destruction" to mean that the critical dimensions of a destroyed component would no longer be measurable or reproducible, that the intended function would no longer be recognizable, or that a destroyed item could not be reconstituted faster or more economically than it could be redesigned or rebuilt.

The IAEA also recommended that some equipment specific to the nuclear weapons program should be scrapped. For example, it asked Armscor to destroy the cages for lowering personnel and cameras into the test shafts at the Kalahari site.

**Dismantling the Kalahari Nuclear Test Site.**

One of the more dramatic dismantlement steps followed the IAEA's request that South Africa render useless the two test shafts at the Kalahari nuclear test site. The IAEA specifically requested that South Africa fill in the test shafts in such a way as to make their reconstitution more difficult or expensive than the construction of new facilities.

Filling in the test shafts turned out to be more difficult to do than expected.[3] Work commenced on June 2, 1993 and was finished by August 1993. This process was recorded by Armscor in a video available on the ISIS web site.[4]

The first task involved removing the concrete and steel plugs over the test shafts. Afterwards, the shafts had to be filled with sand and debris in such a manner that re-drilling would be very difficult. The video contains a schematic of the dismantlement plan (see Figure 1), which essentially alternated layers of sand with steel and concrete obstructions that would damage drilling equipment (see Figure 2). The obstructions were steel drums filled with concrete and scrap metal (see Figure 3).

[3] For a detailed discussion of the Kalahari Test site dismantlement, see David Albright, Paul Brannan, Zachary Laporte, Katherine Tajer, and Christina Walrond, "Rendering Useless South Africa's Nuclear Test Shafts in the Kalahari Desert" (Washington, D.C.: Institute for Science and International Security, November 30, 2011). http://isis-online.org/uploads/isis-reports/documents/Vastrap_30November2011.pdf.

[4] The video can be found at: http://isis-online.org/conferences/detail/destruction-of-south-african-test-shafts-by-iaea-inspectors/13

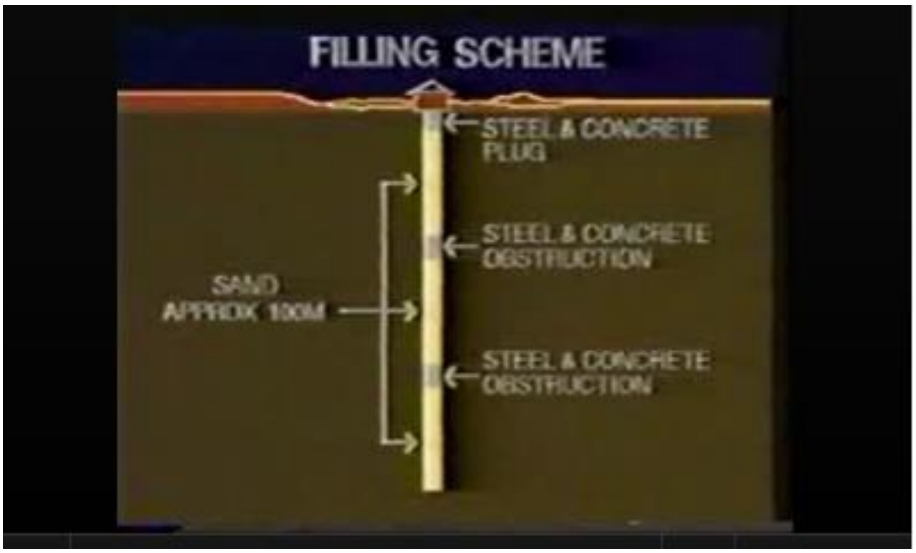


**Figure 1** The plan for filling in the test shafts at the Kalahari test site. Source: Video on ISIS website, footnote 4.

| **PROCEDURE** |
|---|
| Pump water out of test shafts |
| Insert first concrete plug |
| Backfill shaft with sand |
| Insert second concrete plug |
| Backfill shaft with sand |
| Insert third concrete plug |
| Backfill with sand |
| Cast concrete cap on first shaft. Remove equipment |

**Figure 2** Procedure for rendering useless test shaft 1, which was located in the shade.

**Figure 3** Barrels to be inserted into the test shafts at Vastrap by Armscor. Source: Video on ISIS website, footnote 4.

However, while attempting to fill the shafts with sand using a large bulldozer, much of the sand was explosively ejected from the shafts, undoubtedly a result of the over-compression of the air in the shafts (see figures 4 and 5: Sand shooting out of test shaft, Vastrap, June 2, 1993). Ultimately, while dramatic to watch, this problem merely delayed the completion of this task.


**Figure 4** Sand shooting out of test shaft, Vastrap, June 2, 1993. The bulldozer can partially be seen for height reference.

**Figure 5** Casting concrete in test shaft 1 inside the shade (July 1993). Source: IAEA, *Against the Spread of Nuclear Weapons: IAEA Safeguards in the 1990s*, http://www.iaea.org/Publications/Booklets/Safeguards/pia38e14.html

These measures to render useless the test shafts were successfully completed from July 26 to 30, 1993 and were witnessed by IAEA inspectors. The IAEA team visited the Kalahari site in August 1993 and concluded that Armscor had taken sufficient measures to render useless the two test shafts. Their destruction helped South Africa and the IAEA establish internationally that South Africa had indeed dismantled its nuclear weapons program. It also showed that the IAEA had supplemented its inspection efforts associated with the Nuclear Non-Proliferation Treaty.

**Future Transparency Visits.**

In addition to further dismantlement requests, the IAEA also requested South Africa to continue to provide transparency. To that end, it stated that it intended to request access on a case-by-case basis to former nuclear weapons sites and other locations or facilities that it believed warranted inspection.[5] The rationale was based on a recognition that the IAEA's inspection efforts to establish confidence in the absence of undeclared activities necessarily entailed uncertainties. Moreover, a state can resume nuclear weapons activities in secret. The IAEA's conclusions therefore leave open the possibility, however remote, that some undeclared activity has been missed. To reduce these uncertainties the IAEA wanted to conduct additional visits or inspections in the years after the initial revelations and inspections. In the ensuing years, the IAEA has in fact visited facilities associated with the former nuclear weapons program.

**Steps Against Reversal**

South Africa took a number of steps independently to maintain public and international confidence that the nuclear weapons program would not start again or spread. In Waldo Stumpf's view, these efforts, like the dismantling of its nuclear arsenal and joining the NPT, "should be seen in the light of a fundamental reappraisal of South Africa's constructive role in

[5] IAEA, *The Denuclearization of Africa*, op. cit., p. 11.

promoting international nonproliferation."[6] In response, the South African government was increasingly seen as an international leader of nonproliferation and nuclear disarmament initiatives.

Recognizing that it needed to do more than ratify the NPT, the government launched a series of measures to better ensure that nuclear and missile technologies would not be exported to countries that were seeking weapons of mass destruction. In 1992, even before de Klerk's announcement, Armscor established an interdepartmental committee chaired by Gideon Smith, a senior Armscor official and former leader of the nuclear weapons program, to draft nonproliferation legislation specifically aimed at creating a national non-proliferation authority.[7] Smith recommended creating an independent statutory body, but the government decided to place the authority, called the Council for the Non-Proliferation of Weapons of Mass Destruction, under the Minister for Trade and Industry.

The draft bill was finished at the end of 1992 and circulated widely for review, including to the US government. According to a South African Foreign Ministry official, almost all the changes suggested by the United States were included in the final bill. In July 1993 South Africa brought this act into force as the Non-Proliferation of Weapons of Mass Destruction Act (Act no. 87 of 1993).

The act created the national legal framework for the Council for Non-Proliferation and for the government to prevent the development of weapons of mass destruction (WMD), including controlling trade in goods potentially related to WMDs. The act made it a criminal offense for any South African citizen to develop or assist in the development of chemical, biological, and nuclear weapons as well as missile delivery systems for such weapons, including ballistic missiles.[8] This act established national control over the use, import, or export of dual-use equipment, relevant materials, or purpose-built equipment. The list of controlled nuclear dual-use items reflected the dual-use list of the Nuclear Suppliers Group (NSG).

The Nuclear Energy Act (Act no. 131 of 1993) was revised in 1993 to embody the obligations undertaken by South Africa when it acceded to the NPT and signed a safeguards agreement with the IAEA. This act and associated regulations prohibited the export of nuclear materials, equipment, or facilities to non-nuclear weapons states unless they have full-scope IAEA safeguards in operation, a condition that is equivalent to the obligations assumed by members of the Nuclear Suppliers Group. Under this legislation, the AEC was given responsibility to control nuclear exports.

The standing up of the Council for Non-Proliferation involved establishing a range of regulations based on the 1993 Non-Proliferation Act. Many of the arrangements went beyond the efforts of many countries at the time, including some in the NSG. Companies had to register if they possessed, manufactured, or used controlled goods. Exports from South Africa would be subject

[6] Stumpf, "South Africa's Nuclear Weapons Program," op. cit., p. 25.
[7] De Waal, "South Africa's Past Nuclear Program," op. cit., p. 7.
[8] The new South African laws did not provide for the extradition of any person from the former weapon programs working on weapons of mass destruction in another country. If they returned to South Africa, however, they could potentially be prosecuted for violating secrecy agreements.

to extensive end use checks. The Non-Proliferation Council's process of evaluating export requests involved an impressive checklist of factors.

A few problems were identified while the implementation regulations were being debated.[9] The 1993 legislation did not require the establishment of corporate internal compliance systems or a clear mechanism for holding company leaders at fault for illegal exports. Such systems were being developed in Europe at that time as a result of the failures in their implementation of export controls.[10] There were concerns that the South African government would not allocate sufficient resources to implement its export controls and adequately enforce them. One related concern was whether South Africa would seek cooperation with other international organizations and foreign governments, especially regarding problem countries that may use front organizations or trading companies to acquire items from South African companies.

Diplomatically, South Africa took the initiative to become a leader of international and regional non-proliferation efforts. At the April 1995 NPT Review and Extension Conference, South Africa played a decisive role in achieving the indefinite extension of the NPT. Led by nuclear policy experts of the ANC and officials from the de Klerk government, South Africa declared its early support for indefinite extension of the NPT. This strongly affected other members of the Non-Aligned Movement (NAM) and helped to block efforts for a united NAM position advocating limited NPT extension. South Africa's proposal of Principles and Objectives on Nonproliferation and Disarmament, which created a yardstick to measure states' progress on nonproliferation and disarmament goals, was the basis of the formula that overcame the differences between the Western and NAM nations over indefinite extension. According to U.S government, "Without South Africa's contribution, the achievement of the indefinite extension of the NPT without conditions would have been far more difficult."[11] Its action demonstrated the new government's commitment to nuclear non-proliferation and its ability to bridge the gap between the developing and Non-Aligned Movement.

Within the region, South Africa fully supported the creation of an Africa-wide nuclear weapons free zone treaty. The Organization for African Unity (OAU) had sought the denuclearization of Africa for three decades, but progress could not occur until South Africa dismantled its nuclear arsenal. In April 1996, over 40 nations signed the treaty, which is known as the Treaty of Pelindaba in honor of South Africa's role.

**International Incentives**

Although incentives are not typically viewed as a defense against reversal, they created an important motivation for South Africa to stay its course of action. They also served to better

[9] Memorandum by David Albright and Kevin O'Neill, "South Africa Council on Non-Proliferation," November 16, 1994, provided to South African officials.

[10] For more information about the development of internal compliance systems in German companies, see Albright, *Peddling Peril* (New York: Free Press, 2010), Chapter 11.

[11] U.S. Arms Control and Disarmament Agency (ACDA) (now defunct), "Nuclear Proliferation Assessment Statement" pursuant to Section 123(a) of the Atomic Energy Act, as amended, with respect to the Proposed Agreement for Cooperation between the United States of America and the Republic of South Africa Concerning the Peaceful Uses of Nuclear Energy, undated, p. 7.

integrate South Africa into the international community, which has also been an important defense against reversal.

South Africa received several specific incentives for its decision to terminate its past nuclear program and join the NPT, some of which include:

- In the early 1990s, the United States and other Western countries lifted their nuclear sanctions, allowing South Africa to proceed with expanding its sales of uranium and other nuclear materials;
- South Africa and the United States negotiated a new bilateral nuclear cooperation agreement;
- The IAEA re-admitted South Africa to its many bodies, including the General Conference and the Board of Governors. It appointed a South African to the Advisory Groups on Safeguards Implementation (SAGSI) in 1992; and
- South Africa held bilateral discussions with other African states regarding agreements on the use of medical isotopes and training programs. South Africa became a member of the African Regional Cooperative Agreement (AFRA), an IAEA organization that coordinated peaceful nuclear projects in the region.

South Africa also joined a number of international efforts to control exports and prevent the spread of nuclear weapons and other weapons of mass destruction, including the:

- Zangger Committee of the NPT;
- Convention on the Physical Protection of Nuclear Materials;
- Chemical Weapons Convention and the Biological Weapons Convention;
- Conference on Disarmament;
- Nuclear Suppliers Group (NSG); and
- Missile Technology Control Regime (MTCR).

Membership in the NSG and MTCR brought international prestige and access to technology and international markets in nuclear and high tech goods. However, obtaining that membership also required South Africa to take additional steps, some of which would turn out to be painful for Armscor and the defense industries.

**Demise of the Space Launch Program and Tough Controls on Armscor**

Gaining membership to the Missile Technology Control Regime included tough conditions. The United States demanded that South Africa end its space launcher program, the rocket program that US officials viewed as essentially a dangerous ballistic missile program. It also demanded that South Africa further limit its foreign sales of missile goods. The US government also imposed a range of conditions on Armscor (and Denel, a state-owned commercial company that took over the Armscor manufacturing subsidiaries in 1992) because of past illicit trade practices.

South Africa agreed, but the damage to Armscor and in particular Denel was immense. Hundreds if not thousands of high-tech defense jobs were lost.[12]

When the South African government ended the nuclear weapons program, it approved Armscor commercializing what had been a military space program that aimed to launch spy satellites and eventually develop a nuclear-tipped ballistic missile. The space launch/missile programs involved thousands of personnel and conducted three launches of solid-propellant rockets from June 1989 to November 1991, including a two-stage missile that travelled down range from the Oberberg Test Range almost 1,500 kilometers. With the demise of the military program, Armscor was charged with finding commercial, civilian projects. Armscor subsidiaries such as the Oberberg Test Range and Somchem, which made the rocket launcher, became part of the government owned commercial company Denel in 1992 and sought new customers (see figure 6). According to a senior South African foreign ministry official, France was asked to participate, but the cooperation did not materialize.

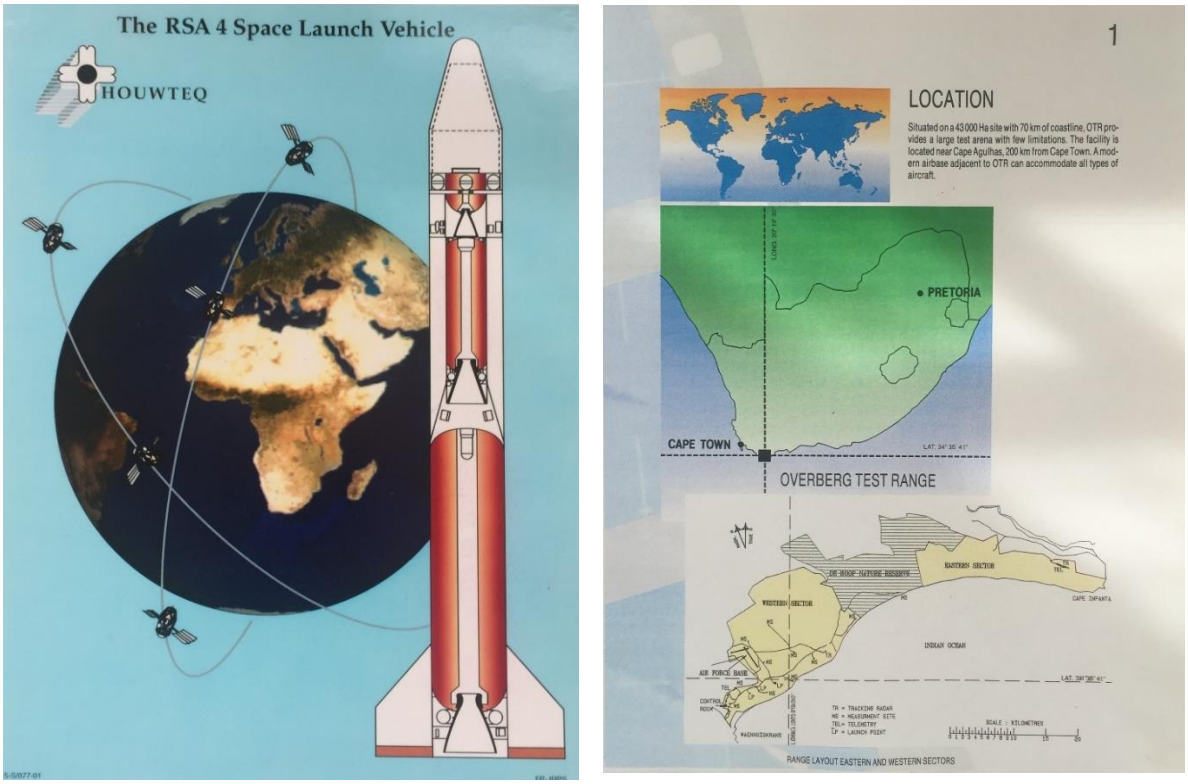


**Figure 6** Examples from Denel's commercial literature advertising its space launch capabilities at Houwteq and the Oberberg Test Range (OTR).

The United States opposed this commercialization. It insisted that South Africa end its indigenous program to build and launch rockets. It did not object to South Africa pursuing its commercial satellite and final-stage booster program, but it wanted any exports tightly controlled and consistent with US and international standards. The level of mistrust between the U.S.

[12] Hannes Steyn, Richardt van der Walt, and Jan van Loggerenberg, *Armament and Disarmament: South Africa's Nuclear Weapons Experience* (Pretoria: Network Publishers, 2003), pp 101-103.

government and Armscor was so high that US officials insisted on witnessing the destruction of the remaining South African launchers, materials, and manufacturing equipment. Denel's rocket division Houwteq destroyed its larger rockets. Somchem destroyed its inventory of rocket fuel, rocket casting pits, and static motor rocket stands. Faced with a lack of funds, South Africa insisted that the United States pay a substantial portion of the destruction costs.

Denel's subsequent commercialization effort was not successful. By mid-to-late 1994, the satellite program was without customers, and these programs were ended as well. The new ANC-led government was no longer willing to subsidize defense industries since funds were needed for national reconstruction, despite the loss of many more high technology jobs.

Further hurting Denel's (and Armscor's) prospects, the US government remained very suspicious of Armscor's past and potential illicit procurement activities, even after South Africa ended its nuclear weapons program and halted its cooperation with Israel on rockets.[13] In 1991 the United States had indicted Armscor, its subsidiary Kentron, and seven South African citizens allegedly acting under instructions of Armscor for illegal exports from the United States that violated the arms embargo.[14] It also banned Armscor from obtaining exports from the United States that were on the MTCR lists.[15] After the ANC took over the government in 1994, it asked the United States to drop the charges. The Clinton administration was unwilling to do so, insisting that these past crimes must be prosecuted.[16] The US Justice Department sought guilty pleas and a fine of $50 million, according to a senior Armscor official.[17] The South African government was unwilling to pay such a high fine or allow Armscor, a government entity, to plead guilty, principally citing the financial demands of national reconstruction. In 1994 Armscor, along with Denel and its subsidiaries, were formally debarred under US law and banned from doing business in the United States. In 1997 a deal was finally reached, whereby Armscor and Kentron pled no contest to violating US export controls and agreed to pay relatively small fines. As part of settling this case, Armscor had to provide information about past illegal procurements and agreed to accept stringent export controls on its trade activities. It also had to create tough internal compliance mechanisms, including a compliance manual approved by the US State

[13] In 1991, the US government waived mandatory US sanctions against Israel as part of an agreement where Israel pledged to stop exporting missile technology to South Africa by the end of 1991.

[14] On October 31, 1991, a federal grand jury in the Eastern District of Pennsylvania returned an indictment charging Armscor and others, but not Denel which did not exist until about 1992, with conspiracy to violate and with violation of the Arms Export Control Act (AECA). The Department of State therefore had reasonable cause to believe that during the period 1978 through 1989, Armscor and the other cited entities engaged in an ongoing conspiracy to export, and did export, defense articles and defense services to the Republic of South Africa and to Iraq without the requisite Department of State licenses or approvals. Effective June 8, 1994, it became the policy of the Department of State to deny all export license applications and other requests for approval involving, directly or indirectly: the Armaments Corporation of South Africa, Ltd. (a.k.a. Armscor), an agency of the South African Government; the Denel Group (Pty.) Ltd. (a.k.a. Denel), a wholly-owned company of the South African Government; Kentron (Pty.) Ltd. (Kentron); Fuchs Electronics (Pty.) Ltd. (Fuchs); William Randy Metelerkamp; Vern Davis; Brian Scott (a.k.a. "Graham Craighness"); Bert Quinn; Johan Lombard; Jaco Budricks; Gerrit Pretorius (a.k.a. "Bull"); and any divisions, subsidiaries, associated companies, affiliated persons, or successor entities [Vol. 59, *Federal Register*, p. 33811, June 30, 1994].

[15] *Federal Register*, p. 51734, October 15, 1991.

[16] Defendants may have been involved in other cases involving exports from the United States to South Africa that were sanctioned by the US government, in particular US intelligence agencies. These sanctioned cases were not prosecuted by the United States; only the non-sanctioned ones.

[17] Interview with senior Armscor official, August 4, 1994.

Department, in order to ensure that its international trade met the highest international standards. After Armscor met all of the conditions set out in the plea deal, the United States dropped sanctions on Armscor temporarily in March 1998, then permanently in 2004.[18]

**Ex-Employees of Advena**

As its problems with the United States intensified, Armscor faced threats from former employees that they would reveal nuclear secrets. These threats occurred against the background that South Africa had committed to preventing ex-employees of the nuclear weapons or ballistic missile program from aiding other nuclear weapons or missile efforts. To that end, Advena Central Laboratories had been commercialized in an effort to find other sources of funding for members of South African nuclear weapons programs. However, the commercialization program was not profitable, and Advena was closed permanently in early 1993.

That closure involved the transfer of the remaining staff to Armscor and other Denel subsidiaries, but also required laying off 60 people.[19] The next year, sixteen of these laid-off individuals threatened to reveal to the highest bidder secret information about nuclear weapons, South Africa's secret cooperation with Israel on missiles, and specialized equipment suppliers in Britain, France, and Germany. In return for their silence, they asked for more than a million dollars in unemployment benefits.

In response, Armscor obtained an injunction barring the 16 from revealing any sensitive information about Armscor's and Denel's armament supply, export, import, manufacture, or research. Armscor officials also visited each of the 16 to ensure that they understood their prior oath of secrecy, the conditions of the injunction, and the danger of their actions. Condemning the threats as tantamount to blackmail, ANC officials supported Armscor's action. Roger Jardine, the ANC's National Coordinator of Science and Technology, told the newspaper *The Citizen*, "The threats can be construed as holding South Africa hostage to a nuclear threat."[20]

As far as is known, the 16 individuals complied with the injunction and admitted that their threat was a bluff, essentially a tactic to negotiate a better retirement package. It is hard to judge the damage they could have done if they had carried out their threat. According to a senior Armscor official knowledgeable about the case, the individuals, of whom only about 2-3 were scientists, had limited knowledge about nuclear weapons. They knew some details about the pyrotechnical side of the nuclear device, but none had knowledge of the entire device.[21] However, they were knowledgeable about the cooperation between Israel and South Africa.

During 1994, as the defense sector continued to shrink, Armscor reached out to the United States for financial help for those who had worked on its nuclear and space launch vehicle programs or possessed skills and know-how that could "contribute to proliferation and who are either

[18] See *Federal Register* notice at https://www.federalregister.gov/articles/2004/07/21/04-16588/bureau-of-political-military-affairs-rescission-of-statutory-debarment-and-reinstatement-of#h-4
[19] SAPA, "Armscor Threatens 'Disgruntled Scientists with Prosecution," *Johannesburg Business Day*, March 30, 1994.
[20] *The Citizen*, March 28, 1994.
[21] Interview with senior Armscor official, March 30, 1994.

unemployed or threatened by lay-offs."[22] In addition to preserving South Africa's industrial capabilities, these efforts aimed at domestically utilizing highly trained scientists, engineers, and technicians in order to keep them from unknowingly or deliberately posing proliferation risks by leaving the country or selling to foreign buyers in South Africa. The Institute for Science and International Security aided in this effort by reaching out to the US government to recommend non-proliferation aid for these South Africans.[23] At the time, the United States was providing assistance to former members of the Soviet nuclear weapons complex at the newly created International Science and Technology Center headquartered in Moscow. Broadening the assistance to South Africa made sense and was certainly needed. However, this effort was unsuccessful, largely due to lack of awareness of the issue and lingering mistrust of Armscor residing among US officials.

Several years later, André Buys studied the fate of the roughly 400 personnel who had been in the nuclear weapons programs at Pelindaba and Circle/Advena right after they left the program.[24] This group is only a small subset of the total number of individuals who produced enriched uranium for weapons or acquired or supplied components, equipment, materials, and services for sensitive nuclear programs. Nonetheless, the group Buys investigated is composed of those who in essence worked on making and maintaining the nuclear weapons themselves. As such, it is a relatively small group but one possessing highly sensitive knowledge and expertise. He found that most were proud of the work they had performed for their country and found it hard to do "ordinary" work again. Only a small minority believed that the program should not have been terminated.

Buys estimated that about 16 percent of this group worked abroad after leaving the program; several individuals reported receiving a nuclear or armaments related job offer overseas. However, he did not report evidence that any of these individuals aided a foreign country's nuclear effort, although he did not have the resources to investigate these cases.

Although the educational level of this group was relatively high, their employment immediately after being terminated was not as lucrative as would have been expected for those who had performed such a vital national security task. The largest fraction of those Buys studied, or 44 percent, indicated that their monthly income decreased after they left the nuclear weapons program. For about 34 percent of this group, their income was unchanged. Only 22 percent reported that their income increased. Overall, Buys concluded that most of these former members of the program did not pose a proliferation risk. However, he assessed that a minority of them did in fact pose a risk. It was namely those that had been laid off, about 40 percent of the total, who then went on to face unemployment and financial hardships. Although he did not quantify this minority, to reduce the risk, he concluded that this subgroup should have received more generous compensation packages and additional assistance finding new employment.

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[22] Facsimile from Gideon J. Smith, Armscor, to David Albright, "Non-Proliferation Initiatives," August 11, 1994.
[23] Letter to Dan Reicher, Deputy Chief of Staff, Office of the Secretary, Department of Energy, from David Albright, President, ISIS, on providing non-proliferation assistance, May 11, 1994. See also the *New York Times* editorial "South Africa's Other Deadly Legacy," May 12, 1994, which recommended joint US/South African projects to put the skills of bomb builders to peaceful uses.
[24] André Buys, *Proliferation Risk Assessment of Former Nuclear Explosives/Weapons Program Personnel: The South African Case Study*, University of Pretoria, Graduate School of Technology Management, July 21, 2007.

Although Buys documented no cases of individuals in this sub group proliferating, he did not investigate those cases where former members had worked overseas. He also did not investigate the larger group of people associated with supplying South Africa's nuclear programs. A few members of that group turned out to be proliferating on a major scale.

**Leakage**

Although the post-apartheid South African export control system contained several innovative measures, it was unable to detect or stop major violations by a small group that had already been secretly supplying Pakistan's and likely others' nuclear programs for many years. Key members of this group spent years helping bust sanctions for the apartheid regime. When business with the regime lessened in the mid-1980s, they turned to helping other countries' nuclear programs. Their illicit proliferation activities continued well past the end of South Africa's nuclear weapons program.

Unlike the group of ex-nuclear weapons people, who were periodically checked on by Armscor authorities in the 1990s, the other, far larger group of individuals who produced enriched uranium for weapons or acquired or supplied components, equipment, materials, and services for the sensitive nuclear programs were largely not scrutinized by trade control officials. Armscor officials from the former nuclear weapons program, who could have helped detect suspicious activities and keep track of former members of the illicit supply chains of the old regime, were largely sidelined starting in about 1995 by the Non-Proliferation Council, when it ended a key contract with Armscor aimed at implementing export controls regulations and practices. Key officials in the AEC from the earlier nuclear program, such as Waldo Stumpf, were likewise losing their positions and influence in the new government, further eroding the ability of government to detect illicit trade.

Later, during the late 1990s and early 2000s South African trade control authorities missed or ignored hints of this group as it expanded its illicit procurements to include a major nuclear weapons program in Libya. It learned of this group only after it was exposed by the United States and Britain. The exposure followed the interdiction by the United States and Britain of the BBC China in October 2003 in the Mediterranean carrying a load of centrifuge parts to Libya. The evidence gathered by the United States and Britain revealed a vast, transnational network of smugglers headed by the Pakistani A.Q. Khan, with a long-established node in South Africa run by this group.[25]

The key members of the South African node were Gotthard Lerch, Gerhard Wisser, Daniel Geiges, and Johan Meyer. From the mid-1980s until 2004, these four individualsand others at their companies became secret suppliers of centrifuge equipment to not only Pakistan, but also Libya, India, and possibly Iran and North Korea. They also tried unsuccessfully to sell centrifuge designs to South Africa's centrifuge program. Until they were exposed following the seizure of the BBC China, they operated their illegal operation in South Africa undetected and mostly unhindered.

[25] The complicated tale of the Khan network is only briefly summarized here. The interested reader is referred to *Peddling Peril*, op. cit. A variety of Khan network reports and related documents can be found on the ISIS web site at http://isis-online.org/peddlingperil.

Lerch was a German, who arranged to buy nuclear and dual-use equipment for Pakistan's gas centrifuge program starting in the 1970s. Frustrated in his attempts to buy these sensitive goods and equipment for Pakistan in Europe with its more stringent trade controls, in about 1985 Lerch recruited Gerhard Wisser, another German who had moved to South Africa years earlier. Wisser had established a lucrative business with the South African nuclear and armaments industry as the agent for the German companies Leybold-Heraeus (later Leybold) and AEG Telefunken.

Wisser was interested in Lerch's new business with Pakistan. In 1984 and 1985, his company Krisch Engineering had lost a substantial amount of its business with the South African nuclear establishment, as it reduced its procurements. Earlier, Krisch Engineering was a "major supplier of systems, components, and technology" to South Africa's nuclear programs, "including its uranium enrichment activities."[26] One senior AEC official said that Wisser was the "AEC's vacuum equipment supplier," among two to three other suppliers.[27] Geiges, a Swiss citizen, joined Krisch Engineering in 1978 and rose to become the company's chief engineer. Meyer met Wisser and Geiges in the 1970s while he was working at the Valindaba enrichment plants run by UCOR. By 1980, Meyer had formed one of his companies, Roxound Engineering Works and started making equipment for UCOR's enrichment plants.

Lerch's choice of South Africa was inspired. In the 1980s, the South African government depended on smuggling for its nuclear programs, and Krisch Engineering was involved in this smuggling. South Africa was unlikely to detect Krisch selling to Pakistan's centrifuge program. What better place to hide a clandestine, illegal procurement operation for Pakistan than within an illegal one for South Africa.

Although South Africa had pledged in 1984 to abide by the guidelines of the Nuclear Supplier Group and not export nuclear goods or sensitive technology to any unsafeguarded nuclear program, it never established a credible enforcement mechanism until 1993 with the passage of the Non-Proliferation and Nuclear Energy Acts.[28] The main intent of the 1984 announcement was to assuage US concerns that the South African government itself would sell sensitive nuclear materials, equipment, and other goods to unsafeguarded programs, not to pledge that it would work to stop South African companies from making such sales without government authorization. In addition, this pledge did not cover dual-use goods, which were a critical part of what Krisch would supply to Pakistan and others.

The individuals in this group left visible traces of their illicit activities. Moreover, members of the group were known to senior nuclear officials because of their earlier procurement activities for South Africa. Meyer did not hide all his sales to sensitive overseas customers; he openly discussed them. One of his company's archived web sites from the early 2000s notes a 1988 export of process piping for an enrichment plant to a sensitive country or customer.[29] The site

[26] "Summary of Substantial Facts," In the High Court of South Africa, The State vs. Daniel Geiges, Gerhard Wisser, and Daniel Geiges and Gerhard Wisser, Directors of Krisch Engineering Co limited, undated. http://isis-online.org/uploads/conferences/documents/SouthAf_Court_summary.pdf
[27] Interview with former senior AEC official, June 3, 2009.
[28] AEC Press Release by J.W.L. de Villiers, January 31, 1984.
[29] *Peddling Peril*, op. cit., pp. 103-104.

adds that if the reader is interested in more information about such a sale, he or she should contact the managing director. However, the AEC, renamed the Nuclear Energy Corporation of South Africa (NECSA) in 1999, and the Non-Proliferation Council did not appear to have the resources or capabilities to detect this web site or other slip-ups by the Khan network.

In the end, the South African node was fully exposed after South Africa received the evidence from the United States and Britain in 2004. Meyer subsequently agreed to cooperate with South African authorities, which guaranteed the success of the prosecutions against Wisser and Geiges. Lerch was tried in Germany and pled guilty. However, the sentences were relatively minor for such a heinous crime.

The Khan case should serve as a reminder to all of the difficulty of controlling nuclear assets and those who supply sensitive nuclear programs. In the case of South Africa, this case should also serve as a lesson that maintaining control over a diminishing nuclear program and its remnants is fraught with uncertainties.