

# A Chronology of South Africa's Nuclear Program

by Zondi Masiza

*Zondi Masiza is a research assistant at the Program for Nonproliferation Studies. He is currently a US AID/Fulbright Scholar at the Monterey Institute for International Studies.*

## Introduction

The recent history of South Africa's nuclear program presents an important and unprecedented case of a state that developed and then voluntarily relinquished nuclear weapons. As we near the 1995 NPT Extension Conference, the case of South Africa presents a significant example for the declared nuclear powers as well as for those considering nuclear deployment. Nuclear weapons may not be the guarantors of regime security that they are purported to be by some supporters. Indeed, there may be sound reasons why other states in the future may also choose to relinquish them or, in other cases, choose not to develop them at all.

This chronology is based on a survey of publicly-available information, principally from the Emerging Nuclear Suppliers Project (ENSP) database. It does not purport to be the final word on the South African nuclear program. Questions remain about which countries, if any, helped South Africa build the bomb and what assistance they provided. If the African National Congress of South Africa (ANC) comes to power in April 1994, some of these lingering questions may be resolved.

The South African nuclear program began in 1944 when Winston Churchill asked then-Prime Minister Jan C. Smuts to make an inventory of South Africa's uranium stock. Smuts, who supported nuclear nonproliferation after the war, once told Churchill that, "...it [the nuclear bomb] will no longer remain a secret, and its disclosure after the war may start the most destructive competition in the world...." Smuts concluded, "If ever there was a matter for international control, this is one."<sup>1</sup>

In the 1950s, South Africa sent its scientists to study nuclear physics in the United States under the aegis of the "Atoms for Peace" program. When South Africa's nuclear program began in earnest in the early 1970s, these scientists were instrumental in its development. Nuclear weapons research was carried out by the South African Atomic Energy Corporation (AEC) under the guise of developing peaceful

nuclear explosives for the mining industry. The sense of urgency in developing a nuclear capability was sharpened by the southward march of the African liberation movement, which the South African government viewed as inspired by the Soviet Union. South Africa conducted its nuclear weapons program in absolute secrecy. Very few government officials and even top Cabinet members knew of its existence.

Throughout the 1970s and the 1980s, the Group of 77 pressured the IAEA to carry out inspections on South African nuclear facilities, such as the pilot uranium enrichment plant. Allegations that South Africa had made preparations to conduct a nuclear test in the Kalahari desert in 1977 increased concern about the country's intentions. But South Africa continued to resist IAEA efforts to carry out inspections. As a result, the Group of 77 removed South Africa from the African seat at the IAEA in 1979. Further resistance led to a move in 1987 to expel South Africa from the IAEA. At this point, South Africa responded to Western pressure by indicating that it would sign the Nuclear Non-Proliferation Treaty (NPT). As a result, the decision to expel it from the IAEA was deferred. Private negotiations between South Africa and the IAEA about accession to the NPT continued.

Shortly after his election in September 1989, South African President F.W. de Klerk informed AEC officials of his intention to discontinue the nuclear weapons program. In July 1991, South Africa finally acceded to the NPT. It subsequently signed a safeguards agreement with the IAEA on September 16, 1991. An AEC official later stated that the possibility of black majority rule contributed to the decision to take these actions. Less than two years after these moves of purported sincerity, however, the international community was shocked by a startling government revelation. On March 24, 1993, President de Klerk disclosed publicly that South Africa had built and then destroyed six nuclear bombs. The program reportedly cost approximately 800 million rand (\$400 million). South Africa still maintains a stockpile of highly-enriched uranium

and has discussed selling the material to the US or UK; however, more recently it has suggested that it will use the uranium at its Safari research reactor or blend the material down to low-enriched uranium.

De Klerk's action has improved South Africa's reputation among African states and has paved the way for participation in the creation of an African Nuclear

Weapon Free Zone. Doubts remain, however, about whether or not de Klerk has disclosed the full extent of South Africa's nuclear weapons program. The ANC, for example, contends that valuable information pertaining to the program has been destroyed by the de Klerk government. IAEA authorities, however, seem satisfied with official statements. The complete story of South Africa's attainment and then renunciation of nuclear weapons probably will not be told until a majority-ruled government comes to power.

### Chronology

- 1944 The British Government asks South Africa Prime Minister Jan C. Smuts to survey South Africa's uranium deposits. The study reveals the existence of large deposits of low-grade ore.<sup>2</sup>
- 1948 The South African Atomic Energy Board is established.<sup>3</sup>
- 10/52 The first South African uranium plant is opened at West Rand Consolidated Mines, near Johannesburg.<sup>4</sup>
- 3/55 As of this date, 16 mines have been authorized to produce uranium.<sup>5</sup>
- 7/57 Under the aegis of the "Atoms for Peace" program, South Africa and the United States (US) sign a bilateral 50-year agreement for nuclear collaboration. Under the agreement, South Africa acquires the Safari-1 reactor and highly-enriched fuel which is delivered at intervals.<sup>6</sup>
- 1959 The research and development program for processing natural uranium is launched by the South African Atomic Energy Board.<sup>7</sup>
- 1965 Allis Chalmers Corporation of the US supplies South Africa with the 20 MW Safari-1 nuclear reactor with 90% enriched uranium. Safari-1 is located in Pelindaba, near Pretoria.<sup>8</sup>
- 1967 As part of its policy to increase its mineral exports, South Africa decides to start enrichment projects.<sup>9</sup>
- 1970s The Atomic Energy Corporation of South Africa (AEC) constructs the "Building 5000" complex at Pelindaba "...with high explosive, criticality, and weapons-manufacturing capability."<sup>10</sup>
- 1970 The enrichment project is made public and the Uranium Enrichment Corporation is established. The AEC begins a uranium enrichment project at a site near Pretoria.<sup>11</sup>
- 3/71 Prompted by the Plowshares Peaceful Nuclear Explosion (PNE) Program, which the US government and the Lawrence Livermore National Laboratory promoted, South African Minister of Mines Carl de Wet approves research on PNE's, which are thought to be useful to the mining industry. The AEC is put in charge of the research. The PNE program marks the beginning of the South African nuclear weapons program. The AEC is said to have "a good technological base with respect to electronics and metallurgy because of its uranium enrichment program," but it has "no expertise in internal ballistics." The AEC acquires information on nuclear weapons construction from open sources, including volumes of declassified data from the Manhattan Project.<sup>12</sup>
- 1974 The United States undertakes the enrichment of uranium ore for fabrication in France in order to produce fuel

- rods for South Africa's Koeberg nuclear power station.<sup>13</sup>
- 1974 A pilot uranium enrichment plant, referred to as the Y-plant by the South African government, begins operation.<sup>14</sup> [Note: conflicting statements have been made about the location of the Y-plant; some sources say that the plant is located at the Pelindaba site; others say it is at the Valindaba site, one-quarter of a mile away. The confusion has been compounded by the fact that South Africa has recently changed the name of Valindaba to "East Pelindaba."<sup>15</sup> For clarity, all references to the Y-plant in this chronology will omit any site names. The Y-plant should not be confused with the semi-commercial plant (also referred to as the Z-plant), which sources agree is located at Valindaba.]
- 1974 The South African government, concerned about the Soviet expansionist threat, decides to build seven nuclear fission devices. The construction of a bore hole at a test site in the Kalahari Desert begins.<sup>16</sup>
- 1975 The South African government, believing that it faces a major threat (what it calls 'Total Onslaught') from the Soviet Union, urges scientists working on nuclear weapon program at the Pelindaba plant to double their efforts toward completing the first test detonation before the end of the year.<sup>17</sup>
- 1975 Throughout the year Safari-1 operates on approximately 105 kilograms of HEU supplied by the US.<sup>18</sup>
- 1975 Bore holes at the Kalahari Desert test site are completed.<sup>19</sup>
- 6/75 South Africa announces that it has completed a pilot plant to produce uranium hexafluoride at Valindaba.<sup>20</sup>
- 1976 The Ford administration suspends shipments of nuclear fuel for the Safari isotope production reactor. The first test nuclear weapons site at Vastrap is completed.<sup>21</sup>
- 1976 The US obtains intelligence data proving that South Africa is embarking on a nuclear weapons effort.<sup>22</sup>
- 4/76 In an uncorroborated report, James Adams claims that South Africa and Israel signed a technical cooperation agreement during the visit of South African Prime Minister John Vorster to Israel. Under the terms of the agreement Israel provides South Africa with nuclear information and sends technicians and scientists to assist in the development of nuclear research, including atomic weapons. Israeli scientists fly to South Africa to provide advice on the establishment of Safari-2, a nuclear research reactor.<sup>23</sup>
- 8/5-8/6/76 The South African Energy Supply Commission (ESCOM) and the French consortium of Framatome-Framateg sign a contract regarding the construction of Koeberg nuclear power station. According to the contract, the French consortium is to "...supply capital works, nuclear fuel and services for Koeberg Units 1 and 2."<sup>24</sup>
- 10/15/76 The governments of South Africa and France formalize the Koeberg negotiations by signing a bilateral agreement.<sup>25</sup>
- 1977 South Africa breaks off safeguards negotiations with the International Atomic Energy Agency (IAEA) regarding a semi-commercial enrichment plant at Valindaba.<sup>26</sup>
- 1977 South Africa barter 50 metric tons of yellowcake for 30 grams of Israeli tritium. The material is code named 'Teeblare' (Afrikaans word for tea leaves) and is shipped secretly to South Africa in small "capsules each containing 2.5 grams." The shipment's timing suggests that 'Teeblare' are meant for the weapons program, but the South African Arms Corporation (Armscor) decides not to use them in manufacturing nuclear devices.<sup>27</sup>
- 1/77 As a result of the suspension of US nuclear fuel shipments, Safari-1 is down-rated to 5 megawatts (MW) and is operated only five days per week.<sup>28</sup>

- 6/77 The AEC's design and engineering team finishes its work on the first tungsten gun device after experiencing timing and projectile-velocity problems. The tungsten was obtained from Rhodesia, Zaire, and Zambia. By this point AEC has gained "expertise in internal ballistics...,as well as experience related to igniters and propellants...." These developments confirm that South Africa has opted for a gun device rather than an implosion bomb.<sup>29</sup>
- 8/77 Due to a lack of HEU, Armscor, which serves as an arms-procurement organization for the South African Defence Force (SADF), makes preparations to test the "first device" by conducting "...a cold test without fitting the device with U-235" in the Kalahari Desert.<sup>30</sup>
- 8/6/77 The Soviet Union discovers, through satellite pictures, that South Africa is making preparations for an underground nuclear test in the Kalahari Desert.<sup>31</sup>
- 12/77 The Y-plant goes into full operation.<sup>32</sup>
- 1/78 The Y-Plant begins producing HEU. The nominal capacity of the plant is believed to be between 10,000 and 20,000 separative work units (SWUs) per annum.<sup>33</sup>
- 2-3/78 As a result of success of the Y-plant, a second and smaller nuclear device is built by AEC "with an intention of loading it with a uranium core... South African officials call the... primary objective of this device a "rapidly deployed, fully instrumentalized test at the Kalahari site, if required...and is "the first provided with HEU." According to AEC Chief Executive Waldo Stumpf, it is only the non-nuclear part of the second device which is completed.<sup>34</sup>
- 10/78 Armscor is charged with the task of manufacturing nuclear weapons, while AEC is to supply uranium and provide theoretical and health physics support.<sup>35</sup>
- 12/78 The Y-Plant produces its first load of HEU. The enrichment level is 80%. Although it is impure and unsuitable for nuclear weapons. Although the HEU is impure and unsuitable for nuclear weapons, the first device is fitted with this HEU. Later, the material is removed, recycled, and the enrichment level upgraded.<sup>36</sup>
- 8/79 A catalytic reaction caused by hydrogen gas and UF<sub>6</sub> forces the Pelindaba reactor to shut down.<sup>37</sup>
- 9/22/79 South Africa and Israel reportedly conduct a joint nuclear test in the South Atlantic. This secret operation is exposed by the US Vela reconnaissance satellite, which detects a "double flash" of light in the South Atlantic. The bomb is reported to be 2-3 kt. Later reports suggest that this test did not actually occur.<sup>38</sup>
- 11/79 The second and smaller nuclear device is provided with HEU. The device has an "estimated yield of 10-18 kilotons (KT) ...meaning that "...the core would contain 40-50 kg weapons-grade HEU or 50-60 kg of HEU if a considerable amount of uranium in the core were enriched to less than 90% U-235."<sup>39</sup>
- early 80s The Reagan Administration approves the sale to South Africa of powerful computers useful in the design and manufacture of nuclear weapons.<sup>40</sup>
- 1980 Two German firms, Neue Technologien GmbH (NTB) and Physikalisch-Technische Beratung (PTB), export an ultrasound device used in the fuel fabrication process.<sup>41</sup>
- 1980 The construction of the Kentron Circle (now Advena), an Armscor facility, begins. The facility is located near Pretoria.<sup>42</sup>
- 1981 The Elprod fuel fabrication facility comes on line; it produces enough fuel for the Safari-1 reactor.<sup>43</sup>

- 1981 Armscor completes construction of two buildings at the Kentron Circle facility. The main building is for designing, manufacturing, and storing gun-type nuclear weapons, while the other is meant for carrying out environmental tests. The tests carried out at this facility serve to ensure that nuclear weapons are reliable without the benefit of full-scale nuclear testing.<sup>44</sup>
- 4/81 The Y-plant begins producing approximately 50 kg of HEU per annum. The HEU is purportedly for the Safari-1 research reactor.<sup>45</sup>
- 1982 MAN-Energie of the Federal Republic of Germany (FRG) supplies the Koeberg nuclear power station with a central mast manipulator and other inspection equipment; it uses this equipment to do pre-service inspections on Koeberg-1 and -2 reactor pressure vessels.<sup>46</sup>
- 1982 The first three batches of UF6 for South Africa's Koeberg power plant arrive at the Franco-Belge de Fabrication de Combustibles (FBFC) nuclear fuel fabrication plant in Roman, France. The UF6 comes from Synaton of Belgium and the Kaiseraugst nuclear power firm - a joint venture of Switzerland, France, and West Germany. The material was enriched at the Tricastin gaseous diffusion plant, a Eurodif facility.<sup>47</sup>
- 1982 South Africa passes the Nuclear Energy Act which makes it illegal to divulge, information concerning uranium reserves, actual or potential output without government permission.<sup>48</sup>
- 1982 The Nuclear Development Corporation of South Africa and the Uranium Enrichment Corporation of South Africa (UCOR) are reestablished as full subsidiaries of the AEC.<sup>49</sup>
- 1982 After four years of research and development commissioned by Armscor's Systems Engineering Division, the gun-type device is refined and the hardware qualified and "requalified." In a 4/93 statement an Armscor spokesperson states that the improved devices exceed the safety requirements which are applicable to a gun-type device. AEC closes Building 5000, which had been used for the design of "two gun-type devices and conducting a criticality experiment...."<sup>50</sup>
- 2/82 South Africa's purchase of enriched uranium from Kaiseraugst (a Swiss utility) is seen as reducing US leverage over South Africa that was provided by a long term South Africa- US Department of Energy uranium enrichment contract.<sup>51</sup>
- 4/82 The Koeberg nuclear power plant is scheduled for completion within 78 months, as stipulated by a contract between South Africa and a French consortium led by Framateg. The plant was provided by Framatome; the project features technology from Westinghouse and quality assurance practices from Gilbert/Commonwealth (US).<sup>52</sup>
- 4/82 Advena manufactures its first nuclear device after a long delay caused by a technical fault at the Y-plant. The device is dubbed a "pre-qualification" model. The design refinement lasts another 2 to 3 years, after which the design is "frozen" for production.<sup>53</sup>
- 4/82 As a result of increased production of HEU at the Y-Plant, South Africa finishes a third nuclear weapon. The weapon-production rate is planned to coincide with the HEU-production rate at the Y-plant.<sup>54</sup>
- 4/82 Before the end of the year, 50 or more modules of UCOR's 300,000 SWUs will be delivered to the Valindaba semi-commercial enrichment plant. UCOR's funding has been reduced by 15%. The reduction will delay the plant's output, which would be at least 3 million SWUs.<sup>55</sup>
- 4/14/82 Swuco and Edlow International, US brokers which bought enriched uranium on behalf of South Africa from

- Belgium's Synatom in 1981, are asked to apply for an export license before the material can be transferred to South Africa.<sup>56</sup>
- 6/82 Swuco and Edlow International of the US broker a deal between European concerns, the Swiss Power Utility Consortium, Belgium's Synatom, and South Africa's Electricity Supply Commission for transfer of approximately 100 tons of excess enriched uranium from the former to South Africa.<sup>57</sup>
- 7/16/82 Chris Von Christierson, South African representative of Nuexco (an international uranium broker), predicts an increase in South Africa's exports of uranium.<sup>58</sup>
- 12/22/82 The African National Congress (ANC) bombs South Africa's Koeberg-1 reactor in retaliation for the South African Defence Force raid on Maseru, Lesotho, in which 42 ANC members and Lesotho citizens were killed. Although no exact figure was given, the damage caused by a series of four explosions to the R1.8 billion complex is reported to be extensive.<sup>59</sup>
- 8/83 Framatome of France sends a repaired set of 18 control rod drive mechanisms to the Koeberg plant in South Africa. Meanwhile, the Koeberg plant undergoes re-welding and is to be checked for leaks as a result of the disclosure that the Framatome-supplied plant had an undercladding cracking problem.<sup>60</sup>
- 9/22/83 The US government allows Westinghouse Corporation to provide technical equipment and maintenance at South Africa's nuclear power station.<sup>61</sup>
- 1983-84 South Africa secretly hires 25 US reactor operators and technicians to work at the Koeberg nuclear power plant; these experts are hired without proper authorization from the US government.<sup>62</sup>
- 1984 The AEC commissions the initial parts of the Valindaba semi-commercial enrichment plant. It is meant to produce low-enriched uranium (less than 5% U-235).<sup>63</sup>
- 2/84 In a move calculated to resolve the dispute over two US Department of Energy enrichment contracts, the AEC announces that it will insist on safeguards as a condition of exporting nuclear material and equipment. The AEC is also ready to resume discussions with the IAEA on safeguarding the Valindaba semi-commercial enrichment plant, but not the Y-plant.<sup>64</sup>
- 4/17/84 Koeberg-1 goes into operation.<sup>65</sup>
- 5/25/84 Pieter van Vuuren, the South African ambassador to Taiwan, says that South Africa will supply Taiwan with uranium if that country wants to increase imports for the generation of nuclear power. South Africa supplies about 70% of Taiwan's uranium needs.<sup>66</sup>
- 7/84 The Swiss Foreign Affairs Department looks into charges that Sulzer Brothers, a Swiss firm, is considering selling a heavy water plant to South Africa.<sup>67</sup>
- 7/5/84 After being questioned by Brian Goodall, a Progressive Federal Party energy specialist, South African Prime Minister P.W. Botha confirms that since 1979 a number of countries have been inquiring about dumping radioactive waste either in South Africa or Namibia. A sum of one billion rand was offered by the FRG and by the United States for a radioactive waste site. The matter was referred to South Africa's Atomic Energy board.<sup>68</sup>
- 7/27/84 Dr. J.W.L. de Villiers, the chairman of South Africa's Atomic Energy Board, denies reports that Sulzer Brothers of Switzerland is about to sell South Africa a heavy water production plant.<sup>69</sup>
- 8/84 South Africa and the IAEA resume safeguards negotiations, broken off seven years earlier, concerning placing

the Valindaba semi-commercial enrichment plant under IAEA safeguards. The South African willingness to place Valindaba under safeguards does not extend to the Y-plant.<sup>70</sup>

- 8/21/84 The French contractor turns Koeberg-1 over to South Africa's Electricity Supply Commission (ESCOM). In June 1984 the AEC gave its consent for pushing production up to 100%. In August Koeberg was issued its commercial operating license. Koeberg-2 is expected to go into full operation in June 1985.<sup>71</sup>
- 11/29/84 As agreed by France, South Africa, and the IAEA, South Africa's high-level radioactive active waste products from its Koeberg plant are to be exported for reprocessing. The reprocessing country is to be responsible for storing the final waste product.<sup>72</sup>
- 12/5/84 A Conference on Radioactive Waste Management is being planned for 9/8-12/86 in Cape Town. South Africa expects more than 250 scientists from 25 countries to participate. Officials expect lobbying for international deposit of nuclear waste in South Africa.<sup>73</sup>
- 1985 Ten buildings are added to the Advenda site, formerly Kentron Circle, in order to facilitate the replacement of the gun-type device with the implosion-type device.<sup>74</sup>
- 1985 Armscor is re-organized in order to facilitate a smooth progression of the nuclear program. The new organizational structure has eight divisions, namely: Program Management and Systems Engineering; Engineering; Technology Development and Explosives; Finances; Security; Health Care; Operations Support; and Personnel.<sup>75</sup>
- 2/23/85 Avner Cohen, a professor of philosophy at Tel Aviv University, and Benjamin Frankel, a professor of political science at the University of Minnesota, claim that the Israeli cabinet may have approved of the Israeli-South African nuclear agreement.<sup>76</sup>
- 2/27/85 South Africa's Atomic Energy Corporation's executive chairman, Dr. J.W. de Villiers announces that since the Valindaba semi-commercial uranium enrichment plant will not come into operation until 1987, the Electricity Supply Commission (ESCOM) will have to continue importing enriched uranium.<sup>77</sup>
- 5/23/85 South Africa's nuclear relations with the West decline as the US, FRG and United Kingdom (UK) terminate cooperation agreements, thereby ending 30 years of "enthusiastic cooperation." South Africa expresses concern that it will not be able to import nuclear safety equipment.<sup>78</sup>
- 6/4/85 The US House of Representatives adopts an amendment on the Anti-Apartheid Bill that bans nuclear cooperation of any kind with South Africa.<sup>79</sup>
- 7/7/85 The second unit of the Koeberg nuclear power station goes critical and commercial service is expected to commence in October 1985.<sup>80</sup>
- 9/9/85 President Ronald Reagan issues an executive order which places new restrictions on nuclear trade with South Africa. However, the order allows certain nuclear items to be exported to South Africa. Furthermore, it does not preclude assistance for IAEA safeguards or IAEA programs generally available to member states, for technical programs designed to bolster nonproliferation, or "for exports which the Secretary of State determines are necessary for humanitarian reasons to protect public health and safety." Department of Energy Secretary John Herrington refuses to retroactively authorize Americans to work at South Africa's Koeberg facility.<sup>81</sup>
- 10/24/85 Senator Alan Cranston and India's Chief of Army Staff General Arlia Vaidya accuse the PRC of exporting nuclear technology to South Africa. The Chinese Foreign Ministry denies allegations of nuclear cooperation with

South Africa.<sup>82</sup>

- 11/11/85 Qian Jiadong, special consultant to the UN delegation, rejects rumors about nuclear cooperation between the PRC and South Africa.<sup>83</sup>
- 11/14/85 The PRC's Foreign Ministry announces that notices have been sent to all countries receiving nuclear exports from the PRC to accept IAEA safeguards. The occasion is also used to deny charges made by US Senator Alan Cranston and other senators that the PRC is exporting nuclear technology to South Africa.<sup>84</sup>
- 1986 The Y-Plant is used to produce LEU for a period of eleven months, because the Z-Plant, a semi-commercial plant, is not fully operational. The LEU (3.25%) is intended for the first four lead test assemblies.<sup>85</sup>
- 2/86 Dr. J.W.L. De Villiers, executive chairman of the AEC, announces that the AEC will offer to sell separative work units (SWU) from its Valindaba semi-commercial enrichment plant on the world market in 1988. The enriched uranium is to be sold at marginal cost - about \$119/SWU.<sup>86</sup>
- 4/86 In spite of sanctions imposed by France against South Africa in 7/85, Framatome is still supplying the Koeberg nuclear power station with nuclear fuel.<sup>87</sup>
- 5/7/86 Scandiflash of Sweden sells South Africa a "roentgen absorber" which makes it possible to carry out a nuclear explosion under laboratory conditions.<sup>88</sup>
- 6/86 Negotiations started in 1984 between South Africa and the IAEA stall, as South Africa demands: (a) the right to withdraw safeguarded enriched uranium produced in Valindaba for nuclear submarine propulsion systems; (b) the right to abrogate the safeguards agreement should its rights and privileges as a member of the IAEA be curtailed. The IAEA finds these conditions unacceptable.<sup>89</sup>
- 7/86 The US Congress passes the "Anti-Apartheid Act" barring uranium imports from South Africa.<sup>90</sup>
- 8/86 South Africa is studying the laser uranium enrichment process. It is also considering exporting small quantities of SWUs.<sup>91</sup>
- 8/7/86 Two people die and two others are seriously injured as a result of a fire inside the Y-plant. According to Frank Pabian of Lawrence Livermore National Laboratory, who was visiting the plant at the time, the fire was caused by a flammable wax polish.<sup>92</sup>
- 10/86 Dr. Wynand de Villiers, executive chairman of the AEC, admits that South Africa is not far behind in uranium enrichment, but he remarks that South Africa's current 3.25% enrichment process is not sufficient for building a nuclear weapon. De Villiers reiterates assurances that South Africa's semi-commercial enrichment plant is to be used for peaceful means.<sup>93</sup>
- 11/10/86 Peter Lomas, a consultant researcher at the Stockholm Peace Research Institute, says that South Africa will be in a stronger position to build nuclear weapons when its semi-commercial uranium enrichment plant at Valindaba goes into operation next year (1987).<sup>94</sup>
- 1987 Perceiving a growing danger of a Soviet "Total Onslaught" in southern Africa, President P.W. Botha considers opening the Kalahari test site. He asks for a schedule for requirements to conduct an underground test. Complying with the request, Armscor assesses the condition of at least one of the Kalahari test shafts; taking care to avoid detection, Armscor erects a 100-meter-long hangar over the test shaft. US and USSR satellites detect the preparations in spite of Armscor efforts.<sup>95</sup>
- 1987 The AEC's semi-commercial uranium enrichment plant is expected to come into commercial production at the



- end of 1987. Valindaba has the capacity to provide 75 tons of 3.25% enriched uranium.<sup>96</sup>
- 1987 A hot cell complex comes on line at Pelindaba.<sup>97</sup>
- 1987 South Africa agrees to sell 2,000 tons of yellow cake to Romania, but then cancels the deal because Romania is not forthcoming with information about safeguard measures to be applied to the material.<sup>98</sup>
- 1/87 France delivers a Thomson-CSF simulator to the Electricity Supply Commission (ESCOM) of South Africa to simulate that company's two Framatome/Alstom units; this is a turnkey contract.<sup>99</sup>
- 1/31/87 The AEC issues a statement to the effect that it has promised the US government that it will observe the spirit and letter of the Non-Proliferation Treaty (NPT) and adhere to the Nuclear Suppliers Group (NSG) guidelines when conducting and administering its nuclear affairs.<sup>100</sup>
- 5/26/87 John Marais, chairman of the AEC, announces that South Africa's nuclear program will be virtually independent of overseas support by 1988. He states that the Koeberg nuclear power station should be utilizing locally enriched uranium. He also states that South Africa has the technology and skill to process uranium which is suitable for use as fuel in nuclear reactors. Safari-1 has been operating with locally manufactured fuel since 1981.<sup>101</sup>
- 8/87 South Africa fails to reach an agreement with the IAEA on a safeguards arrangement for its Valindaba semi-commercial uranium enrichment plant.<sup>102</sup>
- 8/87 South Africa signs and ratifies two international safety conventions.<sup>103</sup>
- 9/21/87 In a calculated move to thwart attempts by the Group of 77 to deprive South Africa of its rights and privileges as a member of the IAEA, the West puts pressure on President P.W. Botha to declare publicly that South Africa will soon accede to the Non-Proliferation Treaty (NPT).<sup>104</sup>
- 12/87 South Africa plans to store its spent fuel from the Koeberg power station at the Vaalputs radioactive waste facility for several decades before shipping it to France for reprocessing.<sup>105</sup>
- 8/88 The Valindaba semi-commercial enrichment plant begins operation. The plant is to supply both the of the reactors at the Koeberg nuclear power station with fuel.<sup>106</sup>
- 8/88 The South African Ministers of Foreign Affairs and Mineral and Energy Resources lead a delegation to the IAEA headquarters in Vienna to discuss the question of NPT accession with the representatives of Britain, the US, and the USSR.<sup>107</sup>
- 8/19/88 Pik Botha, South African foreign minister, tells the media that South Africa has the capability to make a nuclear weapon if it so wished.<sup>108</sup>
- 9/16/88 South Africa sends a letter to IAEA Director General Hans Blix expressing its desire to accede to the NPT if certain conditions are met, primarily that South Africa be allowed to market its uranium, subject only to the IAEA safeguards.<sup>109</sup>
- 1989 About 300 nuclear experts work for the South African nuclear program.<sup>110</sup>
- 1/89 Argentina's Comisión Nacional de Energia Atomica (CNEA) shares design information on nuclear fuel cycle technology with South Africa.<sup>111</sup>

- 5/7/89 US officials confirm that a booster rocket launched from the De Hoop testing range in South Africa on July 5, 1989 has a 900 mile range and is similar to the nuclear-capable Jericho from Israel.<sup>112</sup>
- 6/89 Talks begin between South Africa and the IAEA on opening fuel cycle facilities to inspection.<sup>113</sup>
- 9/89 F. W. de Klerk is elected President of South Africa on 9/14/89. President de Klerk summons Dr. Wynand de Villiers, executive chairman of the AEC, and Dr. Waldo Stumpf and informs them of his intention to terminate the nuclear weapons program and accede to the NPT. De Klerk asks them to draw up a schedule for the task.<sup>114</sup>
- 10/12/89 Derek Smith, a British citizen living in Greece who was arrested in Athens and charged with illegally possessing 5.5 pounds of pure uranium, admits that the uranium found in his possession is a sample from 550 pounds stored in a secret location in South Africa. The material was offered by a South African friend for US\$180,000 per kilogram.<sup>115</sup>
- 10/89 The US Senate is investigating reports that South Africa has obtained information on detonators, explosives, and firing sets from the Department of Energy. The information is not classified, but it may be used in making and testing nuclear weapons.<sup>116</sup>
- 11/89 J.W. de Villiers and Waldo Stumpf report back to President F.W. de Klerk with the dismantling schedule. De Klerk approves the schedule in principle. By this time, Armscor has 6 gun-type nuclear devices stored in Kentron Circle (Advena). The cancellation comes at a time when Armscor is studying the feasibility of implosion-type nuclear weapons.<sup>117</sup>
- 1990 The de Klerk government implements its decision to scrap South Africa's nuclear weapons program. The following steps are taken: all nuclear devices are dismantled and destroyed; all nuclear materials in Armscor's possession are recast and returned to the AEC, where it is to be stored according to internationally accepted measures; Armscor's facilities are decontaminated and used only for non-nuclear commercial purposes; and a date is set for South Africa to accede to the Non-Proliferation Treaty and submit all its nuclear materials and facilities to international safeguards.<sup>118</sup>
- 2/90 The ban on the African National Congress is lifted, and ANC leader Nelson Mandela is released from prison.
- 2/27/90 De Klerk sends written instructions to de Villiers and Stumpf to start the dismantling process. The six completed devices are dismantled; the hardware and technical documentation destroyed; the HEU recast and returned to the AEC; and the Armscor facility neutralized. The Y-Plant is decommissioned. The plant is not under IAEA safeguards because it was built using indigenous technology. Its nominal capacity is reported to have been between 10,000 and 20,000 separative work units (SWUs) per year" which would indicate that it produced between 50 and 100 kg of weapons-grade uranium per annum. Therefore, South Africa is thought to have manufactured between 200 and 525 kgs. of weapons-grade uranium. According to AEC Chief Executive Waldo Stumpf, the Y-plant's decommissioning will not affect the operation of the Safari-1 research reactor because South Africa has enough HEU to supply Safari-1 for years to come.<sup>119</sup>
- 4/90 The United Nations adopts a resolution entitled "Nuclear Capability of South Africa" which calls upon the Secretary General to investigate the alleged cooperation between South Africa and Israel regarding the development of a nuclear-capable missile.<sup>120</sup>
- 4/13/90 Norway exported approximately 450 tons of heavy water between the 1930s and 1988, when the Brundtland government banned further exports. South Africa received 6 to 7 kg.<sup>121</sup>
- 5/4-5/10/90 AEC Chief Executive Waldo Stumpf announces that South Africa is considering exporting enriched uranium

- from its Valindaba processing plant.<sup>122</sup>
- 9/90 MAN-Energie of the FRG is scheduled to perform an in-service safety inspection on South Africa's Koeberg nuclear station.<sup>123</sup>
- 12/90 Framatome supplies the Koeberg PWR with new control rod guide tube split pins and assists South Africa's ESCOM in replacing the rods.<sup>124</sup>
- 7/91 The AEC completes the dismantling of six Armscor-built nuclear bombs; the blueprints and minutes of meetings at which they were discussed are shredded.<sup>125</sup>
- 7/10/91 South Africa accedes to the Non-Proliferation Treaty.<sup>126</sup>
- 8/91 Framatome replaces all 114 control rod guide tube split pins at South Africa's Koeberg-2. Framatome says biological shielding of equipment at Koeberg-1 should be improved.<sup>127</sup>
- 8/91 Edlow International Co., a US firm, asks the NRC for a license to import 1 million kg of U3O8 from South Africa for processing in the US.<sup>128</sup>
- 8/13/91 The US Nuclear Regulatory Commission announces that it will lift the ban on South African uranium imports.<sup>129</sup>
- 8/30/91 General Magnus Malan, South Africa's minister of defense, bans the "development, manufacture, marketing, import and export of nuclear weapons or explosives."<sup>130</sup>
- 9/16/91 South Africa signs a safeguards agreement with the IAEA, effective immediately. Under the terms of the agreement, South Africa is to compile an "inventory of all materials and facilities to be safeguarded." It will allow inspections at all its nuclear sites including its fuel enrichment facilities.<sup>131</sup>
- 9/91 South Africa promises to turn over records of its two unsafeguarded fuel enrichment plants to the IAEA by mid-October.<sup>132</sup>
- 10/18/91 AEC Chief Executive Waldo Stumpf declares that South Africa has "abandoned its nuclear weapons program and is seeking instead to become competitive on the world nuclear fuel market within a few years." He states that the possibility of black majority rule in South Africa contributed to the decision.<sup>133</sup>
- 10/29/91 Information supplied to the IAEA indicates that South Africa may possess weapons-grade uranium. The Y-plant has enriched uranium "far in 'excess' of the 45% level needed for the Safari research reactor."<sup>134</sup>
- 11/15/91 The IAEA begins verification of the declared inventory.<sup>135</sup>
- 12/91 The IAEA meets with the AEC to discuss the inventory.<sup>136</sup>
- 1/92 AEC Chief Executive Waldo Stumpf announces that the enrichment plant at Valindaba is nearing commercial production capacity. AEC is also thinking of testing "...a prototype molecular laser isotope separation (MLIS) enrichment unit."<sup>137</sup>
- 1/11/92 A Danish researcher says South Africa is providing employment for about 500 experts from the former Soviet nuclear arms industry.<sup>138</sup>
- 2/92 The Atomic Energy Corporation considers the commercial packaging of uranium, conversion, enrichment,

- fabricating and spent fuel storage services. Under one plan, AEC would "rent" fabricated fuel to utilities overseas, and would take it back to South Africa for storage after the fuel had been burned.<sup>139</sup>
- 2/7/92 South Africa admits that it has enriched uranium to weapons-grade level. Leonard Spector, a researcher at the Carnegie Endowment for International Peace, says that South Africa has been able to produce around 50 kg of HEU per year since 1981. That amount would produce 20 to 30 nuclear weapons.<sup>140</sup>
- 3/92 AEC Chief Executive Waldo Stumpf announces that South Africa is planning to test a prototype molecular laser isotope separation (MLIS) uranium enrichment unit around 1994. Currently South Africa relies on the indigenous "helikon" jet-nozzle separation process.<sup>141</sup>
- 4/9/92 Kenya announces that it will propose that South Africa join the African Energy Agency (AFRA) at the organization's annual meeting (4/25/92-5/1/92). South Africa and Kenya are to sign a nuclear cooperation agreement which would include exchange of nuclear technology and information as it applies to medicine and agriculture.<sup>142</sup>
- 9/92 South Africa starts blending down some of its HEU (more than 20% U235) to low enriched uranium (less than 5%).<sup>143</sup>
- 9/92 South Africa informs the US at the IAEA general conference in Vienna that it will sell its abundant supply of HEU to the US and Britain. The US welcomes the idea because "...it would be the easiest way of resolving the biggest nonproliferation problem in southern Africa."<sup>144</sup>
- 9/16/92 South Africa's Atomic Energy Corporation and Kenya's National Council for Science and Technology sign an agreement to cooperate on nuclear energy programs. The two countries will collaborate in training, research and energy supply. The collaboration may lead to a joint energy protocol.<sup>145</sup>
- 9/12/92 The IAEA establishes that South Africa's Y-plant produced more than 400 kg of weapons-grade uranium during the 1970s and 1980s.<sup>146</sup>
- 10/30/92 In accordance with NPT requirements, South Africa submits its inventory of nuclear materials to the IAEA; the records date back 15 years.<sup>147</sup>
- 1/93 The AEC destroys all documentation of proliferation concern except the material accounting and material transfer records.<sup>148</sup>
- 3/93 AEC Chief Executive Waldo Stumpf says that as a result of commercialization, the AEC has reduced its dependence on government funds from R685 million in 1991/92 to R300-451 million in 1992/93. AEC reprocesses "low and intermediate level nuclear byproducts from the nuclear industry," but it will not offer this service internationally.<sup>149</sup>
- 3/23/93 The AEC and Armscor destroy design information and associated documentation on the nuclear weapons program.<sup>150</sup>
- 3/24/93 South African President F.W. de Klerk announces in parliament that South Africa had built and then dismantled 6 gun-type nuclear weapons; the seventh nuclear weapon was dismantled before it could be finished. According to de Klerk, the program cost South Africa 800 million rand (about \$400 million). De Klerk states that there was no collaboration with foreign governments on the project. At the same time, Armscor reveals that it had operated a clandestine nuclear weapons manufacturing site - formerly known as the Kentron Circle, now known as Advena - just 25 km west of Pretoria. Approximately 1,000 experts were involved during the entire life span of the nuclear program; at its zenith about 400 were employed. South

African officials say that these six devices were fueled with HEU from the Y-plant and equipped with tungsten reflectors. They were reputed to have a yield of 10 to 18 kilotons (KT) - similar to the 15-KT gun fission bomb dropped on Hiroshima. Insofar as the model was concerned, Armscor states that the devices "were identical in principle, but some changes in detail were made to enhance reliability. Armscor officials say that the "feasibility of a ballistic missile was studied...it was rejected on the grounds that the additional deterrence afforded by such a delivery system was limited in terms of South Africa's nuclear strategy." De Klerk stresses that South Africa had neither developed thermonuclear bombs nor carried out a test in the South Atlantic.<sup>151</sup>

- 3/26/93 An unidentified Times (London) informant confirms De Klerk's assertion that South Africa had no collaboration with foreign governments regarding its nuclear weapons program. The informant, who is a foreign specialist, had top triple-X security clearance allowing him access to all aspects of the nuclear weapons program. The informant said he saw no other foreign advisor during the time he spent in South Africa. Israeli assistance was very limited and at a low level.<sup>152</sup>
- 3/26/93 The IAEA holds talks with South African officials to work out details for special inspections to verify that South Africa no longer has nuclear weapons.<sup>153</sup>
- 5/18/93 The South African Parliament passes the Non-Proliferation of Weapons of Mass Destruction Act, which commits South Africa to abstain from developing nuclear weapons.<sup>154</sup>
- 6/93 According to the AEC Executive General Manager for Fuel Production, P.J. Venter, the AEC is faced with a low demand for nuclear fuel in the South African market. Therefore, the AEC is looking for export markets for conversion, enrichment, and fuel fabrication services. It is estimated that excess AEC production capacity between 1993 and 1997 will be "1,750,000 kg U as UF<sub>6</sub> conversion services, 250,000 SWU, and 200,000 to 300,000 kg U PWR fuel fabrication."<sup>155</sup>
- 7/23/93 In an address to US officials and journalists, AEC Chief Executive Waldo Stumpf states that South Africa plans to maintain part of its stockpile of HEU for use at the Safari research reactor, which has recently been upgraded to 20 MW. Stumpf says that South Africa has blended down the rest of the stockpile to LEU for use in the Koeberg plant. However, some US firms are continuing to discuss the possibility of purchasing the HEU, and sources say that the South Africa is still willing to sell "most, if not all, of the stockpile."<sup>156</sup> The HEU sale was expected to net South Africa 15 million rand; the conversion is expected to raise 500 million rand.<sup>157</sup>

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