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**NUCLEAR WEAPONS:
IMPLICATIONS FOR AFRICA**

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Abstract

The prevention of nuclear proliferation has become a high priority for the international community. The paper analyses the rationale for -- and against - this high priority, viewing it as a means to the end of preventing nuclear war rather than as an end in itself. It then proceeds to analyse the proliferation risks in Africa, finding them to be quite insignificant. The former (unofficial) nuclear weapons state South Africa has destroyed its nuclear weapons and joined the Non-Proliferation Treaty, and Libya has apparently abandoned its former nuclear ambitions, whereas other potential nuclear proliferants such as Egypt were never very serious in their quest for nuclear weapons. Africa is thus mainly of interest in a non-proliferation context by virtue of its uranium deposits. While the most important producers are today under satisfactory control, it is conceivable--but not very likely--that uranium mining will become economically feasible in other countries in the future, depending mainly on the price of uranium ore. Due to the generally low technological level and the almost complete absence of processing facilities, it is deemed highly unlikely that any new nuclear powers will emerge in Africa.

I. Global Proliferation Issues

Since the end of the Cold War, a specific discourse has gained almost universal prominence even though it seems to defy plain common sense—that the proliferation of nuclear weapons to new states and perhaps non-state actors is the main problem, whereas it has ceased to be a problem at all that the existing nuclear weapons states maintain their much larger and more sophisticated arsenals, which are even being continuously upgraded.

A lot of international attention is therefore paid to the nuclear non-proliferation regime inaugurated by the Non-Proliferation Treaty (NPT), whereas other forms of nuclear arms control are being systematically disregarded. On closer analysis, however the NPT reveals itself as just one piece in a much larger puzzle, or as one element in the endeavour to eliminate or at least limit the risk of nuclear war, preferably without thereby increasing the risk of conventional war.

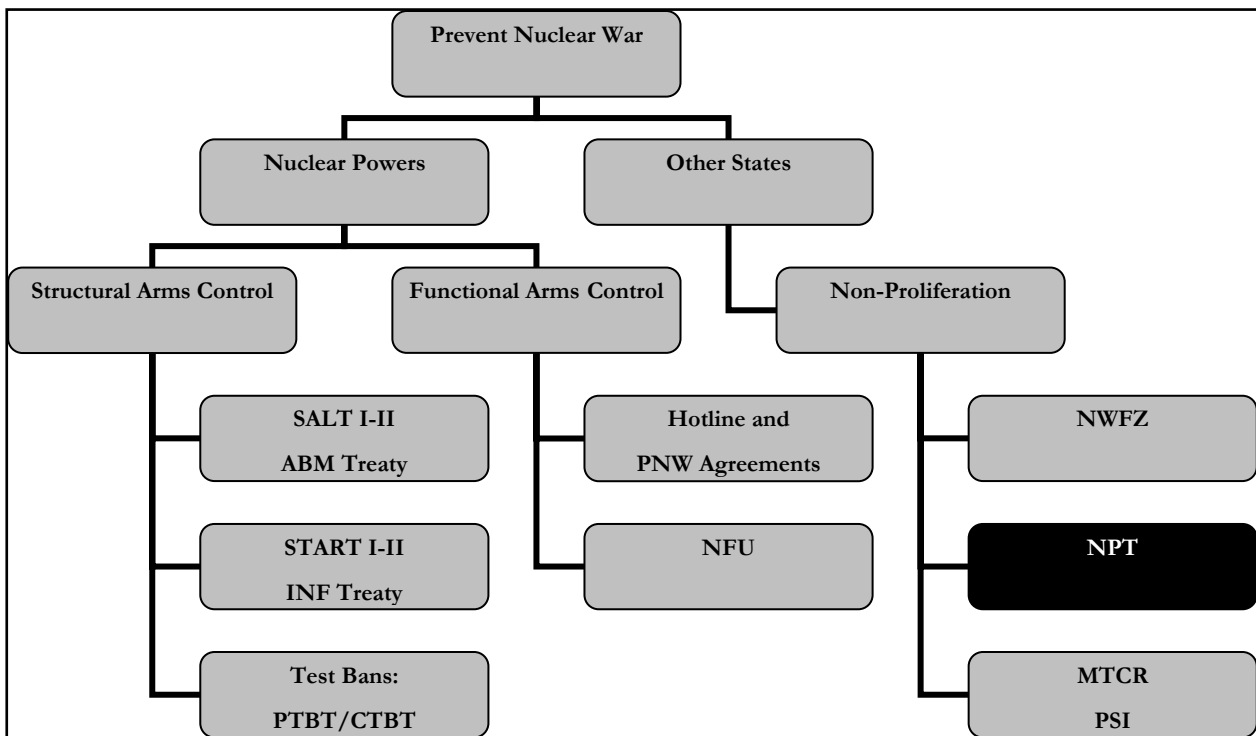


Fig. 1: Nuclear Arms Control and the NPT

I.1 PREVENTING NUCLEAR WAR: ARMS CONTROL

As summarised in Fig. 1, other elements of nuclear and nuclear-related arms control may be grouped into measures intended to reduce or otherwise modify nuclear arsenals (structural arms control) and constraints on nuclear activities (functional arms control).

From the category of structural arms control, the following deserve mentioning:¹

- Attempts to halt the strategic nuclear arms race between the United States and the Soviet Union, e.g. with the SALT (Strategic Arms Limitation) treaties of 1972 and 1979, respectively, of which only the former entered into force.²
- Modest attempts to reverse this arms race, e.g. in the form of START (Strategic Arms Reduction Treaty) or (on a regional scale) the INF Treaty; banning intermediate-range nuclear missiles.³
- A quest for arresting or at least slowing down the technological arms race by proscribing nuclear testing with the Partial Test Ban Treaty (PTBT) followed by a Comprehensive Test Ban Treaty (CTBT).⁴
- Proscriptions or limitations on non-nuclear arms programmes such as defences against nuclear attack with the potential of leading to or accelerating nuclear arms races, as was the rationale for the 1972 ABM (Anti-Ballistic Missile) Treaty.⁵
- Control of particular technologies which might make nuclear war more likely, e.g. the use of MIRVs (multiple independently-targeted re-entry vehicles) on strategic nuclear missiles, limited in the START II treaty and the preceding bilateral “de-mirving” agreement.⁶
- Efforts to stem the geographical spread of nuclear weapons, e.g. into the seabeds of the world’s oceans, in Antarctica or in outer space.⁷

From the category of functional arms control, we might mention the following:

- Efforts to prevent nuclear wars by accident or misunderstanding, e.g. via the establishment of a Hotline in 1963 and by means of the PNW (Prevention of Nuclear War) agreement.⁸
- Proposals for banning either the use or, as a minimum, the first-use of nuclear weapons;⁹

All of these measures addressed, albeit with rather meagre results, what would logically appear to be the main problem, i.e. the nuclear weapons of the states with the largest and most sophisticated arsenals, directed against each other and at a very high level of readiness.

Perhaps even more important than the actual treaties and conventions listed above was the general norm which gradually became almost unchallengeable that nuclear weapons should not be used, i.e. what has been called the “nuclear taboo.”¹⁰ It had already been suggested in 1946 by Bernard Brodie, who argued that “Thus far the chief purpose of a military establishment has been to win wars. From now on its chief purpose must be to avert them. It can have no other useful purpose.”¹¹ This admonition was, however, soon forgotten by the Eisenhower and Kennedy administrations,¹² but following the Cuban Missile Crisis of 1962 it gained ground again—partly due to domestic policy considerations.¹³ Former Secretary of Defence Robert MacNamara thus probably spoke for the overwhelming majority of the US polity with his assertion that “Nuclear weapons serve no military purpose whatsoever. They are totally useless—except to deter one’s opponent from using them.”¹⁴ Nevertheless, both the Carter and the Reagan administrations as well as (to a slightly lesser extent) those of Bush senior and Clinton continued to flirt with the notion of counterforce potentials that just might make limited nuclear war appear as a rational policy option—and the most recent US nuclear posture review, undertaken by the Bush Junior administration took major steps in this direction.¹⁵ The USSR only gradually came around to accept the mutual deterrence paradigm. Having done so, however, they seemed to stick more closely to it than the United States.¹⁶

1.2 NON-PROLIFERATION

By the early 1960s, the proliferation of nuclear weapons to other states, i.e. the US allies Britain and France as well as the former Soviet ally China, became a major issue. The fear began to spread of an uncontrollable proliferation which might also involve medium-sized powers.¹⁷ This was seen as problematic for several reasons:

From a global point of view it was feared that the risk of nuclear war was almost proportional to the number of nuclear weapon states, or even that it would grow exponentially with a rise in their number—an argument often made in strictly mathematical terms and labelled “the Nth country problem.”¹⁸ It was the same logic which made Kenneth Waltz (and others) prefer a bipolar to a multipolar system because of its presumed stability.¹⁹ Nevertheless, Waltz (and a few like-minded International Relations Realists such as John J. Mearsheimer) have subsequently argued in favour of a gradual proliferation, believing in the “socialising” effects of the possession of nuclear weapons.²⁰

From the point of view of the nuclear “haves” it threatened to undermine their special status and erode their power position. The fewer nuclear weapons states the better—in fact, the ideal situation of every nuclear power was to be the only power with nuclear weapons, as seems to

have been the hidden agenda behind the Baruch Plan promoted by the United States from 1946 to 1947 as a partial precursor to the NPT.²¹ The nuclear powers sometimes argued their case for non-proliferation with references to the specific character of the suspected prospective proliferants—something which may not have been intended as, but was nevertheless perceived as highly discriminating, xenophobic or “islamophobic,” especially when there was talk of an “Islamic bomb” as especially destabilising.²²

From the point of view of the nuclear “have-nots”, there was more ambivalence. On the one hand, a number of countries did (at different historical junctures) actually have nuclear weapons ambitions, including Argentina and Brazil in South America,²³ Sweden and Switzerland in Europe,²⁴ Taiwan and South Korea in East Asia,²⁵ India and Pakistan in South Asia, Iraq and Israel in the Middle East, Egypt and Libya in North Africa, and the apartheid regime in South Africa (see below). However much these countries wanted nuclear weapons, none of them were eager to see their respective regional rivals or enemies armed with nuclear weapons. For quite a few of them, therefore (although not for South Africa), the real choice was thus one between, on the one hand, nuclearisation with a bilateral nuclear stand-off as the most likely medium-term outcome with all the accompanying risks and costs or, on the other hand, a bi- or multilateral regional denuclearisation. Most countries saw the latter as the lesser evil, even though Israel chose the nuclear path,²⁶ as did Iraq even though its ambitions in this respects were foiled, first by an Israeli attack in 1981 and then by its defeat in the Gulf War of 1991.²⁷ In 1998, both India and Pakistan also went openly nuclear with nuclear tests.²⁸

This was the political background for the NPT, but there were all along parallel attempts at stemming nuclear proliferation on a regional scale

- Most important have surely been comprehensive initiatives such as the creation of nuclear-weapons-free zones (NWFZ).²⁹ The first NWFZ agreement was negotiated in Latin America in 1967 (the Tlatelolco Treaty).³⁰ During the Cold War, several moribund plans were advanced for an all-European NWFZ as well as for zones covering Central Europe³¹ or the Nordic region.³² More recently NWFZ have been negotiated for Southeast Asia (the Treaty of Bangkok),³³ the South Pacific (the Rarotonga Treaty)³⁴ and Africa (the Pelindaba Treaty, more on which below).³⁵ Finally, the two Koreas in 1992 signed an agreement on the denuclearization of the Korean Peninsula, which was, however, soon to be violated by North Korea.³⁶ Proposals have also been made for a NWFZ for the Middle East, first proposed by the Shah of Iran in 1974. It was subsequently endorsed by Egypt and other regional powers. Egypt took a new initiative to the same effect in the wake of the Gulf War (4 July 1991), and resolutions were passed by the UN General Assembly in 1991 and 1993 endorsing the concept. Indeed, it was even mentioned in Security Council resolution SC-687 on Iraq,³⁷ only soon to be forgotten by the West.
- Test bans such as the aforementioned CTBT would also (if abided by) go a long way towards preventing states from crossing the nuclear threshold. Even though it is surely possible to assemble a fully functional nuclear weapon without tests, without at least one successful test of it, neither the state in question nor the rest of the world will know whether it would work and its possessor's nuclear weapon status would thus remain questionable—as is to some extent the case of Israel. Even though a non-tested nuclear weapon might still have considerable value, all other proliferant states have therefore chosen to proceed to the testing stage.
- One might also mention the Missile Technology Control Regime (MTCR) which is intended to prevent prospective nuclear proliferators (and others) from acquiring suitable means of delivery.³⁸

The most important component of the counter-proliferation endeavour was, however, the NPT Treaty, which was opened for signatures in 1968 and entered into force in 1970. Since then follow-up conferences have been held every five years, none of which have, however, changed much with regard to the basic provisions of the treaty.³⁹ Most countries have by now acceded to the NPT, including some of the former “threshold states” (but neither India, Pakistan or Israel) and only one country (North Korea) has withdrawn from it. A special case is that of Taiwan which cannot sign the treaty because of its lack of international recognition as a state, but the government in Taipei has nevertheless pledged to behave as if it were a member.⁴⁰

The basic formula of the NPT was that of a *quid pro quo* even though the “quids” have never really matched the “quos.”⁴¹ The nuclear have-nots have committed themselves not to develop nuclear weapons, in return for which the nuclear haves pledged to provide negative security guarantees to the have-nots (i.e. promises not to attack them) and to work towards nuclear (and general) disarmament, as well as to facilitate the peaceful use of nuclear energy—an element which had been the mainstay of the aforementioned Baruch plan as well as Eisenhower’s “Atoms for Peace” initiative.⁴² None of these pledges have, however, been implemented. Whereas some of the nuclear powers offered negative security assurances, the United States (which had provided them, albeit with some reservations, to the signatories of the Tlatelolco Treaty) has been vacillating between outright refusal and attempts at watering down the assurances with substantial reservations and exception clauses.⁴³ There has been no movement towards nuclear disarmament and additional obstacles have been placed in the way of peaceful exploitation of nuclear energy by the non-nuclear-weapons states.

Stringent supply-side constraints have also been enforced by the Nuclear Suppliers Group (a group of 45 states capable of supplying nuclear fuels and materials that could be used in a military programme) and the Zangger Committee.⁴⁴ In addition to these multinational (but not universal) initiatives, the US has also unilaterally launched several initiatives such as the Counterproliferation Initiative⁴⁵ and, most recently, what it has called the Proliferation Security Initiative (PSI),⁴⁶ envisaging among other things the boarding of ships suspected of carrying nuclear-relevant material to potential proliferants. It is based on bilateral agreements with individual states and the number of signatories is growing. By the end of 2006, however, only three African states had signed up: Angola, Libya and Liberia.⁴⁷

1.3 PROLIFERATION CASCADES?

The actual developments have not really confirmed the alarmist expectations of the proliferation pessimists.⁴⁸ The total number of nuclear weapon states has grown from one (the USA) in 1945 to eight proclaimed (the USA, Russia, China, the UK, France, Pakistan, India, and North Korea) and one unofficial (Israel) nuclear weapon states in 2007. Even though this does, of course, amount to an eight-fold increase, a closer look at the actual pace of proliferation provides more comfort (see Table 1).

Table 1: Timeline of Nuclear Proliferation

Status		Decade						
		1940s	1950s	1960s	1970s	1980s	1990s	2000-2006
NUCLEAR WEAPONS	Acquired	USA USSR	UK	China France Israel	India†	South Africa	India Pakistan Russia* Ukraine* Belarus* Kazakhstan*	North Korea
	Abandoned						South Africa Ukraine, Belarus Kazakhstan	
Total		2	3	6	7	8	8	9

Legend: †: Peaceful nuclear explosion; *: Legacy from the USSR

Not only have the expectations of US President Kennedy and others that by 1975 the world would have 15-20 nuclear weapons powers⁴⁹ not at all been realised, but the sequence of proliferation steps also does not seem to correspond with the often-encountered image of a “cascade” (i.e. a chain reaction where one state’s proliferation provokes others to follow suit).⁵⁰ In fact the only two “mini-cascades” have been the nuclear weapons acquisitions of the USA and the USSR in the 1940s, and those of India and Pakistan in the 1990s. What is also obvious is that the movement is not unidirectional, but that proliferation is reversible. South Africa thus voluntarily gave up the nuclear weapons in the development of which it had invested quite a lot (see below);⁵¹ and three of the successor states of the USSR voluntarily abandoned the nuclear weapons which they had, almost by coincidence, “inherited.”⁵² To this should be added the fact that several “threshold states” (i.e. non-nuclear states with nuclear weapons ambitions) have abandoned their former quest for nuclear weapons and joined the NPT, as was the case of Brazil and Argentina,⁵³ whose example was recently followed by Libya (see below).

There have most recently been speculations about possible proliferation cascades following North Korea’s actual nuclearisation in 2006 and the likely consequences of potential Iranian nuclear weapons. However, the former seems to have provoked neither South Korea nor Japan sufficiently to make them reconsider their non-nuclear policies—and it strains the imagination to envisage any proliferation cascade if or when Iran perhaps crosses the nuclear threshold. Israel already has nuclear weapons and both Iraq and Saudi Arabia are likely to regard the present US nuclear “umbrella” as preferable to a costly and perhaps futile quest for national nuclear capabilities.

On the other hand, one cannot completely discount the alarmist predictions. The revelations about the clandestine proliferation network of Abdul Qadeer Khan, (the “father” of Pakistan’s

nuclear weapons) seem to indicate that there have been concerted attempts by a few prospective proliferants to circumvent or evade the NPT and other regimes.⁵⁴ However, even here, there is less new than meets the eye, as the Khan network resembles the collaboration in the past between global outcasts or pariahs such as Israel, Taiwan and South Africa⁵⁵—as well as the organised crime syndicates which have long been involved in a black market for nuclear material stemming from the former USSR.⁵⁶

Even more alarmist threat assessments envisage that terrorist groups such as *Al Qaeda* could exploit “proliferation rings” such as the AQ Khan network to acquire nuclear weapons. If this were to happen, it would surely be a cause of serious concern, as such groups would almost certainly have few inhibitions against using nuclear weapons and would be impossible to deter by threats of retaliation.⁵⁷ However, from the realisation that such “catastrophic” or “apocalyptic” terrorism would indeed represent a major disaster it does not follow that it is likely at all. Much more likely (or rather much less unlikely) would be that terrorists might lay their hands on radioactive materials (e.g. non-enriched or even depleted uranium) and use this for radiological weapons, better known as “dirty bombs.” Fortunately, however, the destruction following such an attack would be quite modest and the safeguards against it rather obvious.⁵⁸

2. Africa and Nuclear Proliferation

2.1 PROLIFERATION RISKS IN AFRICA?

There has never been any great enthusiasm for nuclear weapons in Africa—in fact various African organisations have passed several resolutions against them, for example against French nuclear tests in the Sahara desert in the early 1960s. Apart from Egypt, Libya and South Africa (see below), the only African countries that have ever expressed an interest in joining the nuclear club have been Nigeria and Gabon—the former only for a very brief period, mainly for peaceful use and partly as a counter to the South African nuclear programme, and the latter with a request from then President Omar Bongo to France for a nuclear power-station which was understandably rejected and has never been repeated.⁵⁹

Even though Africa has substantial uranium deposits and production, what is lacking (besides political will) are both the general technological and industrial foundation and the more specific technologies related to the nuclear fuel cycle, except in the case of South Africa (see Table 2).

Table 2: Nuclear Fuel Cycle Facilities in Africa

Facility Country	Name	Type	Status	Scale
Egypt	Fuel Element Fabrication Plant	Fuel fabrication	In operation	Pilot plant
	Inchas Nuclear Fuel Laboratory	Fuel fabrication (PHWR)		Laboratory
Gabon	Mounana	Uranium ore processing	Decommissioned	Commercial
Morocco	Jorf Lasfar - Khouribga	U recovery from phosphates	Deferred	Commercial
	Safi - Youssoufia			
Namibia	Rössing	Uranium ore processing	In operation	Commercial
Niger	Arlit	Uranium ore processing	In operation	Commercial
South Africa	Beva	Fuel fabrication (LWR)	Shutdown	Commercial
	Pelindaba Fuel Fabrication	Fuel fabrication (MTR)	In operation	Pilot plant
	Beisa	Uranium ore processing	Shutdown	Commercial
	Blyvooruitzicht		Decommissioned	
	Buffelsfontein		Decommissioned	
	Central Processing Plant		Shutdown	
	Driefontein		Decommissioned	
	East Rand		Decommissioned	
	Freegold		Decommissioned	
	Harmony (Merriespruit)		Decommissioned	
	Hartebeestfontein		Shutdown	
	Palabora		Shutdown	
	Randfontein (Cooke)		Decommissioned	
	Stilfontein		Decommissioned	
	Vaal Reefs - 1		Shutdown	
	Vaal Reefs - 2		In operation	
	West Rand Consolidated		Decommissioned	
	Western Areas		Shutdown	
	Western Deep Levels		Shutdown	
	Valindaba (Laser)	Uranium enrichment	Deferred	Pilot plant
Valindaba Y - Plant		Decommissioning		
Valindaba Z - Plant		Decommissioning	Commercial	
Valindaba (UF6)	Conversion to UF6	Shutdown		
Pelindaba Zircaloy Tubing	Zircaloy tubing	Shutdown		
Tunisia	Gabes	U recovery from phosphates	Under study	Commercial

Not only is Africa thus nuclear-weapons free, but it also strains the imagination to envision any change in this regard. Indeed, Africa has been home to three cases of “nuclear reversals,” Egypt,

South Africa and Libya, all of which have been pursuing nuclear status or even achieved this, only to subsequently abandon their nuclear ambitions.⁶⁰

2.2 EGYPT

The Egyptian nuclear weapons programme seems never to have been a really high priority.⁶¹ It was first launched by President Nasser and continued under his successors, Anwar Sadat and Hosni Mubarak. It initially took the form of a request for “off-the-shelf” nuclear weapons addressed to the Soviet Union and China in 1965 and 1967, respectively. As both requests were turned down, Egypt approached India for a collaboration agreement, which was signed in 1970, but produced very little actual assistance to Egypt. Ambitious plans for an indigenous nuclear weapons production capability, based on a full nuclear fuel cycle, had to be abandoned by 1981, when Cairo signed the NPT. What actually came out of these endeavours was, first, a very small (2MW) research reactor followed by another reactor with a greater capacity of 22MW, which was still quite insufficient for producing weapons-grade material.

There seems to be no significant risk that Egypt may want to resume its nuclear programme and even less grounds to fear that it might be successful this time. It never seemed particularly serious in the first place, even though it seems to have been provoked by the clandestine Israeli nuclear weapons programme.⁶² Since that time, a “cold peace” has been signed with Israel,⁶³ and it is unlikely that this will break down—unless, of course, a complete regime change were to occur, e.g. in the form of an electoral victory for the Muslim Brotherhood who just might decide to want to construct an “Islamic bomb.” Even in this (entirely hypothetical and quite unlikely) eventuality, Egypt would be very unlikely to succeed.

2.3 LIBYA

There has been more international concern about Libya’s nuclear weapons programme, mainly because of the rather unpredictable nature of the regime,⁶⁴ which was even labelled a “rogue state” by the United States, both because of its sponsorship of international terrorism and its proliferation efforts.⁶⁵

Libya’s quest for nuclear weapons seems to have begun almost immediately after the coup which deposed King Idris in 1969.⁶⁶ The new leader, Colonel Muammar al-Gadhafi thus approached first China (1969-71) and then France, India and the USSR in the second half of the 1970s for “off the shelf” equipment, but to no avail. He then tried to “shop around” for equipment for indigenous production with rather meagre results, even though he claimed only to be interested in peaceful uses of nuclear energy (e.g. for seawater desalination), and in 1975 ratified the NPT

which the king had signed in 1968. Eventually the USSR consented to selling Libya a small research reactor which went into operation in 1981.

Because of the tight constraints imposed by the NPT and other of the aforementioned anti-proliferation regime elements, Libya through the 1990s chose to rely mainly on clandestine deliveries of both equipment and technical assistance through the A.Q. Khan network mentioned above, supplemented by efforts to recruit scientists from other Arab countries. There have even been speculation that Libya's intervention in neighbouring Chad and its de facto occupation of the Aouzou Strip from 1973 to 1994 were partly motivated by the hope to be able to mine uranium.⁶⁷ The main constraints seem neither to have been a lack of political will or of money to fund the programme but rather the lack of an indigenous industrial and knowledge base.

The rationale for the quest for nuclear weapons was never quite clear, as Libya has never really had any serious enemies—except, of course, for the United States which launched an air attack against it in 1986 in retaliation for Libya support for a terrorist attack against US forces.⁶⁸ Even though this may well have strengthened the Libyan desire for a nuclear deterrent, it cannot really explain what had begun fifteen years earlier. A better explanation may be Israel's nuclear weapons, even though an Israeli attack on Libya was never really on the cards. Indeed the only thing that might have given Israel a motive for such an attack would be the perception that Libya was about to go nuclear. Gadhafi may, however, have viewed the Libyan bomb-in-the-making as a contribution to pan-Arabism, providing a joint Arabian deterrent against Israel. In 1987 Gadhafi thus proclaimed that

The Arabs must possess the atomic bomb to defend themselves until their numbers reach one billion, until they learn to desalinate seawater (sic!), and until they liberate Palestine. We undertake not to drop the atomic bomb on anyone around us, but we must possess it. (...) If there is going to be a game using atomic bombs, then it should not be played against the Arab nation. (...) This is an essentially defensive weapon.⁶⁹

Since the late 1990s, however, Libya has reversed course almost completely in several respects.⁷⁰ Its geopolitical and cultural/ideological orientation has shifted from pan-Arabism to pan-Africanism, making it, among other things one of the main promoters and sponsors of African integration;⁷¹ and it has exhibited a strong interest in mending its relations with the West, not least the United States, first by discontinuing its sponsorship of international terrorism and even paying compensations to the victims of the PanAm-103 terrorist attack;⁷² and then by a complete abandonment of its proliferation plans.

The motives for abandoning the nuclear programme may have been partly economic—as the economy had been deteriorating, albeit from a very high level—and partly related to a revised view of the country’s security interests. Rather than seeing nuclear weapons as a likely contribution to national security, the regime came around to regarding them as a threat to the very same security.⁷³ In December 2003, Libya announced its intention to implement full disarmament of its weapons of mass destruction (WMD) programme (including chemical weapons) under full international supervision—and then proceeded to actually do so to everybody’s complete satisfaction. As of today, Libya thus possesses neither weapons of mass destruction nor missiles with ranges in excess of the 300 kilometres permitted by the MTCR.

2.4 SOUTH AFRICA

As the only African country to have developed nuclear weapons, and a full nuclear fuel chain, South Africa deserves special attention. From the outset, South Africa’s nuclear ambitions were supported by the USA and other Western countries. It was one of the first countries in the world to produce uranium (as a by-product of gold mining), with assistance from the UK and the USA, and nuclear research programmes began in the mid-1950s. In 1957 the South African government signed a fifty-year agreement with the USA under Eisenhower’s “Atoms for Peace” programme, and the following year a South African team was invited to witness US nuclear weapons tests. In the 1960s, the US supplied a research reactor and enriched uranium to power it. US supplies of enriched uranium were terminated as a result of the apartheid regime’s refusal to join the NPT in the mid-1970s, but by then the country had embarked on its own enrichment programme, and by 1978 was diverting much of the product to the production of highly-enriched uranium (HEU) for nuclear weapons. Despite this, by as late as 1981, South Africa was the third largest recipient of US nuclear exports. With French assistance, a nuclear power station was constructed at Koeberg near Cape Town in the 1970s, thus completing the nuclear cycle, except for reprocessing (which only a few countries can do).⁷⁴

The apartheid regime adopted a similar stance to that of the Israelis: while it was obvious to most informed observers that it was developing – or had already developed – nuclear weapons, with the support of its international backers in the West, it did not declare its capabilities.

Nevertheless, during the 1970s and 1980s there were a number of events that pointed towards South Africa’s nuclear weapons capabilities, some which still remain shrouded in secrecy or mystery. In 1974 a nuclear test site was built in the wastes of the Kalahari desert at Vastrap in the Northern Cape. It was detected by a Soviet surveillance satellite and the US pressured South Africa into dismantling it, apparently without it ever being used. Then in 1979 a US satellite registered a double flash usually associated with a nuclear explosion in the South Atlantic Ocean,

where a South African warship was present. The evidence around this remains inclusive, but at the time the CIA apparently reported to the US National Security Council that the most likely explanation was that a tactical nuclear weapon had been tested jointly by the South Africans and Israelis.⁷⁵

In 1990, after the unbanning of the ANC and other resistance organisations, and the onset of negotiations to end apartheid, then President F.W. de Klerk ordered the dismantling of South Africa's nuclear weapons capabilities. Three years later, he admitted that six nuclear weapons had been built, with a seventh under construction at the time of the dismantling. Subsequently it was revealed that these were 'old fashioned' Hiroshima-type bombs that could have been launched from British Buccaneer naval bombers in the possession of the South African Air Force, or from other South African aircraft.⁷⁶ It is possible that preparations were also being made to develop nuclear warheads for missiles, as South Africa had a rapidly-expanding missile programme at the time.

Many questions remain unanswered about South Africa's nuclear weapons programme. The South African History Archive has listed these amongst them:

- Was it the intention from the early 1970s, when South Africa was developing 'peaceful nuclear explosives', to develop nuclear weapons?
- Was the programme designed only for gaining diplomatic leverage or did it have a military purpose?
- What exactly were the foreign sources of technology (linkages with Israel are strongly suspected but have never been proved, and the extent of US, West German and French support is not clear)?
- Was a new generation of weapons under development?
- Was foreign pressure put on South Africa to sign the NPT (it stretches credulity to the limit to believe that the US and other major Western powers did not know of the nuclear weapons programme)?
- And finally, 'was fear of a democratic (i.e. a black) government possessing a nuclear arsenal a significant factor behind the decision to dismantle?'⁷⁷

In July 1991 South Africa became a signatory to the NPT, dismantled its bombs, and subsequently placed its HEU under international safeguard, dismantled its enrichment and other plants, and opened all its facilities to inspection by the IAEA, to the organisation's satisfaction (although its reports were never made public).⁷⁸ Documentation related to the programme was

destroyed, but there remained some questions about the role of some of the scientists, and years later cases were recorded of South Africans smuggling nuclear technology to countries such as Libya.

After the first democratic government came to power in 1994, South Africa entered the world arena as the first country to have voluntarily relinquished its nuclear weapons (even though under a previous regime) and was able to use to good advantage, playing a central role in the 1995 NPT Review and Extension Conference, and bridging the gap between the Non-Aligned Movement and the Permanent Five UN Security Council members (see below).⁷⁹ It also drove the process of establishing the Pelindaba Treaty (named after one of South Africa's main nuclear facilities) that set up a nuclear-weapons-free zone for Africa and its island states.

2.5 AFRICA AS A NUCLEAR-WEAPONS-FREE ZONE

As early as 1964, at the first ordinary session of the OAU, the African states passed a declaration on the denuclearisation of the continent (Cairo Declaration). It was followed up with a Declaration on Security, Disarmament and Development in 1986, but only in 1996, after the apartheid regime had dismantled its nuclear weapons programme and South Africa had made its transition to democracy, did the African states agree on an African Nuclear-Weapon-Free Zone Treaty, better known as the Treaty of Pelindaba. For its entry into force, 28 ratifications were required, but by the end of 2006 only 22 states had ratified: Algeria, Botswana, Burkina Faso, Equatorial Guinea, Gambia, Guinea, Ivory Coast, Kenya, Libya, Lesotho, Madagascar, Mali, Mauritania, Mauritius, Nigeria, Rwanda, South Africa, Senegal, Swaziland, Tanzania, Togo, and Zimbabwe.

The treaty is to a large extent built on the model of the Tlatelolco Treaty, by constituting the treaty itself, setting out the rights and obligations of the African members, and additional protocols open for the signatures of others, the nuclear powers and the remaining colonial powers (Spain and France). In the treaty itself, the signatories pledged neither to “conduct research on, develop, manufacture, stockpile or otherwise acquire, possess or have control over any nuclear explosive device.” (art. 3), as well as not to allow the stationing of nuclear weapons or the conduct of nuclear tests on their territories (arts. 4-5). Any signatory would have the right to withdraw, “if it decides that extraordinary events, related to the subject-matter of this Treaty, have jeopardized its supreme interests,” but only after a twelve-months “grace period.” The five official nuclear powers, in turn, were invited to sign and ratify Protocol I, thereby renouncing their “right” to “use or threaten to use a nuclear explosive device” against any of African signatories (art. 1), and with Protocol 2 they were invited to pledge themselves to refrain from

nuclear testing in Africa (art. 1), a pledge reiterated in Protocol 3, applying only to France and Spain as the last colonial hold-outs. The only exception appears to be the island of Diego Garcia, to which Mauritius lays claim, but which is recognised as British territory and has been leased to the US for a military base – on which there are almost certainly, at some times at least, nuclear weapons.⁸⁰

2.6 AFRICA AS A URANIUM SUPPLIER

In the run-up to the invasion of Iraq, the UK and the United States argued their case for the need to disarm Iraq with reference to an alleged Iraqi purchase of Uranium from Niger. Even though this soon turned out to be either a deliberate fraud or at least a complete misunderstanding,⁸¹ such clandestine uranium deliveries to prospective non-African proliferants are, in principle, conceivable, especially where government writs do not run strongly.

Indeed, in July 2006, a United Nations (UN) investigation team submitted to the chair of the UN sanctions committee, concluded that there was "no doubt" that a large shipment of smuggled uranium 238, hidden in a consignment of coltan, and uncovered by customs officials in Tanzania, had originated from uranium mines near Lubumbashi in the Democratic Republic of the Congo. The Shinkolobwe mines there, which supplied the uranium for the bombs that the US dropped on Hiroshima and Nagasaki, were closed in the early 1960s when the departing Belgians poured concrete down the mineshafts, but they have reportedly been reopened by local illegal miners. The shipment was destined for the Iranian port of Bandar Abbas, allegedly for forwarding to Kazakhstan, where the coltan would be smelted, but Western commentators assumed the uranium would stay in Iran.⁸²

The only significant producers of uranium in Africa are Niger, Namibia and South Africa, of which only the latter has a technological and industrial potential for a full nuclear fuel cycle—even though only the mining capacity remains along with the actual power plants.⁸³ Other major uranium producers in the world are Australia, Canada, China, Kazakhstan, Russia, the United States and Uzbekistan (see Fig. 1).

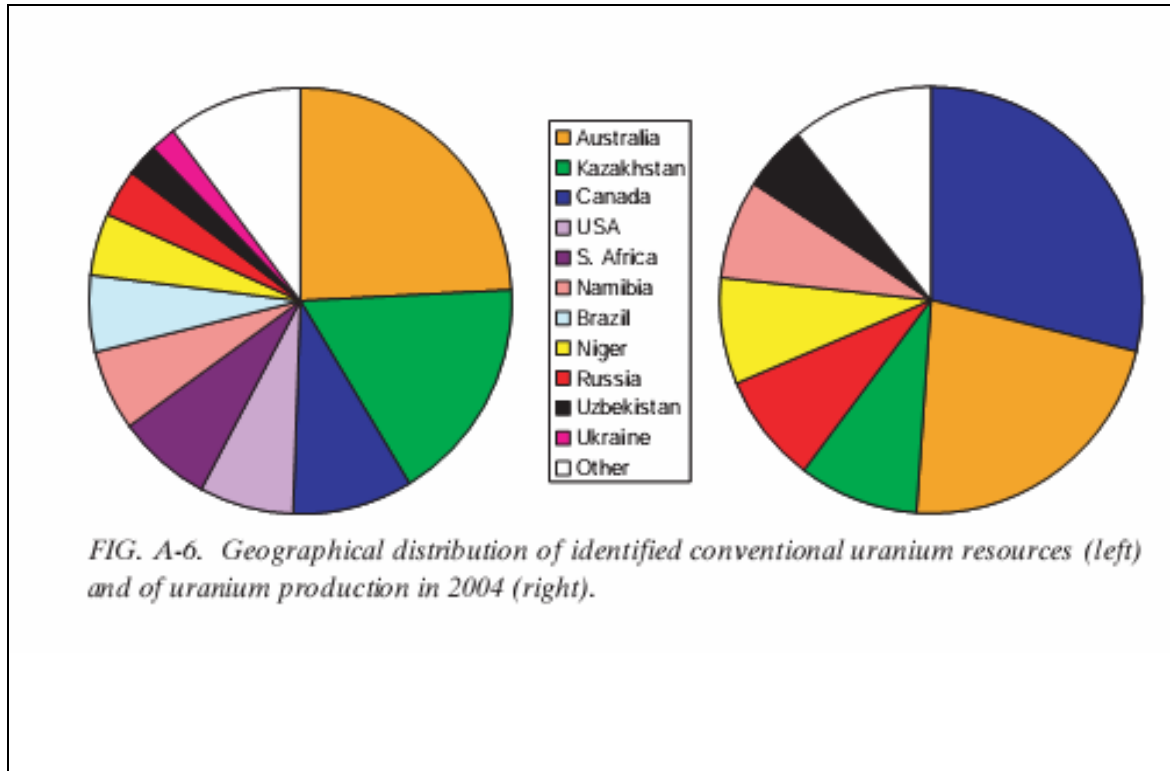


Fig. 2: Uranium Resources and Production

- Gabon was a minor producer until the late 1970s, but has ceased mining completely.
- In Niger, two uranium-producing companies have been in operation since 1970 and 1978 (SOMAIR and COMINAK, both with government shares of one-third) with production capacities of 1500 and 2300 tonnes of uranium p.a.—and with an actual annual production of around 3000 tonnes.
- Namibia has one operational uranium mine with a nominal production capacity of 4000 tonnes p.a.
- South Africa has one operational mine, run by AngloGold Ashanti, with an annual production (as a by-product of gold mining) of around 1000 tonnes (2002). Its only conversion plant (Valindaba) was shut down in 1998, its two enrichments plants (Vallindaba Y and Z) closed in 1990 and 1995, respectively, and its fuel fabrication plant (Beva) in 1996. Two nuclear reactors were in operation in 2002 at the Koeberg nuclear power plant with an annual electricity production of 12.588 TW-h. However, there are plans to open two other sites (see below).

Besides these three countries, however, several other African countries might become relevant in the future as indicated by the listing of uranium deposits in Table 3.

Table 3: Uranium Deposits in Africa

Country	Status						Unknown	
		Dormant	Depleted	Empty	Explored	Developed		Operating
Algeria		Abankor						
		Daira						
		Tahaggart						
		Timgaouine						
		Tinef						
Cameroon		Kitongo						
CAR		Bakouma						
DRC		Kamoto						
		Kasompi						
		Shinkolobwe-Kasolo						
Gabon		Bangombe	Boyindzi					
		Mikouloungou						
		Mounana						
		Okélobondo Nord						
		Okélobondo Satellite Nord						
		Okélobondo Satellite Sud						
		Okélobondo Sud						
	Oklo							
Madagascar		Antsirabe						
		Folakara						
		Fort Dauphin Occurences						
Malawi		Kayelekera						
Morocco		Gantour						
		Khouribga						
		Meskala						
		Oued Eddahab						
Namibia		Auris			Langer Heinrich	Rossing		
		Engo Valley						
		Goanikontes						
		Hakskeen						
		Klein Trekkopje						
		Mile 72						
		Tumas						
	Valencia							
Niger		Abakorum	Arlette			Artois	Akola	Marianne
		Akouta Sud	Taza Nord		Ebala	Ebba Nord	Akouta Nord	Marthe
		Imouraren	Taza Sud		Tamgak	Ebba Sud	Ariege	Maryline
			Takriza			Tabelle	Tamou	
Somalia		Alio Ghelle						
		Dusa Mareb						

Country	Status						Unknown
	Dormant	Depleted	Empty	Explored	Developed	Operating	
South Africa	Blyvdoruit-zicht	Phalaborwa				Buffelsfontein	
	Chemwes-Stilfontein	Dormant				Hartebeestfontein	
	Driefontein Mine					President Brand Mine	
	Free State Geduld Mine					President Steyn	
	Harmony					Vaal Reefs Mines	
	Lorraine					Western Areas Mine	
	Randfontein Mine					Western Holdings	
	St.Helena (Beisa Section)						
	West Rand Mine (U Section)						
	Western Deep Levels Mine						
Zimbabwe	Kanyemba	Dormant					

It has been argued that African uranium mining is set to expand quite dramatically, particularly because of recent price increases which make formerly unprofitable mining ventures financially attractive,⁸⁶ and new deposits may be discovered. Indeed, in the first months of 2007, the Angolan government announced that it had discovered uranium reserves.⁸⁷ The DR Congo also intends to explore for more reserves, and signed an agreement late in 2006 with a British company owned by a number of major Western firms, Brinkley Mining company, to "explore, evaluate and develop the country's uranium resources, including the production of nuclear materials".⁸⁸

Some analysts' have argued that nuclear power may be the solution to the Third World's and Africa's energy shortages (see Table 4), but no major steps in this direction have been taken in Africa, nor do any seem likely in the foreseeable future, unless South Africa leads the way – as it may do (see below). It should be noted that along with the discovery of uranium reserves, the Angolan government declared that was "interested in looking at developing nuclear power, despite the country's large petroleum and hydro-electric potential", and presented to parliament a draft Law of Atomic Energy, related to "the production and use of nuclear energy".⁸⁹ However, this would be a long way to go for a country with Angola's low technological and knowledge base in relation to nuclear issues.

Table 4: Per Capita Electricity Use (2003)

Averages	(kW-h)	Examples	(kW-h)
Africa	593	Ethiopia	33
OECD	8,612	South Africa	4,997
World	2,670	United States	14,040

2.7 IMPLICATIONS OF SOUTH AFRICA'S EXPANDING CIVIL NUCLEAR PROGRAMME

While the post-apartheid government has shown no interest in renewing a nuclear weapons capability, it has, especially in the last two or three years, tilted strongly towards reviving a civil nuclear power programme. Initially this was based around the development of what was touted as “revolutionary technology”, the Pebble-Bed Modular Reactor (PBMR), which was originally developed in Germany and the USA but refined in South Africa. Essentially this is a mini-reactor filled with hundreds of thousands of “pebbles” consisting of graphite and enriched uranium dioxide - the design is meant to be safe and efficient. However, as design costs escalated, technical problems mounted and potential markets outside of South Africa withered, enthusiasm for the project appears to have waned.⁹¹

Without abandoning the PBMR, the South African government has now embarked on a process of building more conventional nuclear reactors on the Koeberg model. This follows global trends, where countries as diverse as China, Russia, Taiwan and Australia are building reactors for power-generation, given rising costs of fossil fuels, concerns about global warming and greater comfort about the safety of nuclear reactors. It is also driven by a chronic shortage of electricity in South Africa, where major cities have faced regular black-outs and considerable pressure has been put on the grid by economic expansion. And the new reactors may also form part of a renewed South African effort to become an important actor in the global nuclear arena, especially in Africa.

In February 2007, after much speculation that six or even thirty reactors might eventually be built, Public Enterprises minister Alec Erwin announced that a new nuclear power station would be built ‘in the southern part of the grid’ – almost certainly next to Koeberg which is already licensed for another two reactors.⁹² As with Koeberg, French companies were at the forefront of the bidding to build the plant.

More surprisingly, again after much speculation, Minerals and Energy Minister Buyelwa Sonjica announced shortly afterwards that South Africa would re-embark on a uranium enrichment programme “before year end”, possibly with French or Russian support. Such a programme

would be in line with South Africa's commitment to develop local beneficiation capacities, would ensure a reliable supply of enriched uranium for the new PBMRs and conventional reactors, and could set South Africa up as an exporter of enriched uranium. This could be extended to reprocessing of spent fuel.⁹³ This is surprising because few countries find it cost-effective to enrich their own uranium – only ten countries do so, and many of them do so through joint ventures to save costs – while even fewer are capable of reprocessing. It is difficult to envisage how South Africa could find this cost-effective.

One clue may lie in its evident ambitions to spread nuclear technology throughout Africa. In November 2006 the Minister of Minerals and Energy held a two day-meeting with African “energy decision-makers” comprising an executive committee called Powering Africa: The Nuclear Option. She said that Africa possessed significant uranium resources which should be beneficiated (enriched) and used to generate energy, that regional approaches should be adopted to building a nuclear infrastructure and that discussions were taking place with Nigeria to establish a regional nuclear and radiation regulatory forum. Strategic partnerships would be required with countries that had extensive nuclear programmes, and “deliberate and calculated planning on behalf of the leaders of the continent” was needed – South Africa was already developing its own strategy. “Africa in particular needs nuclear energy”, she concluded.⁹⁴

In parallel, South African companies have been developing plans to expand uranium mining – it possesses the fourth largest reserves in the world but they are largely under-exploited (see Fig 1). A company called Uranium One has started work on a mine near Klerksdorp and a small mining company, Simmer & Jack, has plans to exploit uranium in its slimes dams at Bufflesfontein and Randfontein. South African companies have also indicated an interest in exploiting resources at the Kanyemba deposit in Zimbabwe. The Nuclear Energy Corporation has also announced plans to build a new smelter for the future disposal of domestically-generated nuclear waste. South Africa also supplies one quarter of the world's radioactive medical isotopes, which are exported from OR Tambo international airport.⁹⁵

Clearly, although it has no intention of resuscitating its nuclear weapons programme, South Africa has great intentions of expanding its domestic nuclear capabilities, through the full cycle, and expanding nuclear technology into Africa. This in part explains some of its foreign policy positions, in particular in relation to Iran's enrichment programme, which brings us back to the problem of nuclear weapons (from which it is often difficult to separate civil nuclear issues).

3. Policy Challenges for Africa and South Africa

It may be asked why South Africa is “separated” from the rest of Africa in this section. The answer, of course, is that as the only African country with an internationally-recognised nuclear technological base, and a former nuclear weapons power, which is also represented on the board of the IAEA, South Africa may have somewhat different interests in the nuclear game to other African countries, and certainly will carry more punch, as has been seen in the NPT Review processes. Nevertheless, to a large extent, South Africa occupies common policy territory with the rest of Africa, and has sought to promote the positions of the Non-Aligned Movement, the African Union and the G-77, sometimes acting as interlocutor between these groups and the P5.

The position of the African Union and most African countries on nuclear weapons issues and non-proliferation can generally be summed up as follows:

Adherence to the Pelindaba Treaty, so that Africa remains a nuclear-weapons-free zone. With Libya now falling into line, there are no African states contemplating developing or hosting nuclear weapons. The issue of warships from the P5, which may or may not have nuclear weapons on board, however, is a vexed one. For the most part, African countries hosting such ships (for R&R, official visits or peacekeeping purposes) assume that they do not have nuclear weapons on board and since this is neither confirmed nor denied the issue is fudged.

- Emphasis not only on the non-proliferation aspects of the NPT but also on the provisions for disarmament. As noted at the beginning of this paper, this issue – that the P5 signatories to the NPT are expected to disarm, but have shown little if no inclination to do so – has somehow been allowed to slip off the global radar screen. This was the issue that divided the 1995 NPT review conference, with the NAM countries resisting an indefinite extension of the treaty without regular review and the establishment of “yardsticks” with which to measure disarmament by the P5.⁹⁶
- An insistence that any steps taken against states allegedly violating the NPT or developing nuclear weapons outside of the NPT should be done through multilateral institutions such as the IAEA, or where necessary the UN Security Council. Hence the opposition of most African countries (although not all) to the US invasion of Iraq on the grounds of its possession of WMD, and the reservations of many African countries about Security Council actions against Iran.

- Concern – especially from Egypt – about the tolerance of Israel’s nuclear weapons and the fact that it has not signed the NPT. This again has been a major issue in the review conferences. The fact that some African countries, such as Egypt and countries in the Horn, are essentially more part of the Middle East security complex than African ones, complicates the issue of proliferation. For example, it has been posited that a ”cascade” might follow the possible development of nuclear weapons by Iran, with Sunni countries such as Saudi Arabia wanting to counter a ”Shia bomb” – and where would this leave Egypt over the long term? The prospects of such a cascade do, however, seem quite remote.
- With its nuclear technology base, and its ambitions to expand it (including through enrichment) South Africa feels perhaps a stronger concern than other African countries about P5 (especially Western) attempts to prevent Iran from enriching uranium. This may explain in part why it held out until the last moment on the Security Council against such actions. As Rob Adam, head of South Africa’s Nuclear Energy Corporation put it rather bluntly, the problem is that developed countries seem to want to control the expansion of nuclear activity, and Western powers’ effort to stop Iran from enrichment demonstrate that.⁹⁷ Likewise, in August 2006, after meeting with her Iranian counterpart, South Africa’s Minister of Foreign Affairs, Nkosazana Dlamini-Zuma reiterated ”the basic and inalienable right of all NPT states to develop research, production and use of nuclear energy for peaceful purposes without discrimination”.⁹⁸
- India and Pakistan, as developing countries with which many African countries share a policy solidarity, pose particular problems, especially for South Africa with its close ties to India. South Africa’s position is clear: despite India’s failure to sign the NPT, and its development of nuclear weapons, President Mbeki has indicated that as a member of the NSG, South Africa would support a bid by India – backed by the US (providing it can be pushed through Congress) to have access to technology for its nuclear power stations (this is on the basis that India has ”separated” its civil nuclear programme from its military one).⁹⁹

4. Endnotes

¹ The texts of all the following agreements are reprinted in Burns, Richard Dean (ed.): *Encyclopedia of Arms Control and Disarmament* (New York: Charles Scribner's Sons, 1993), vol. III.

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³ On START see Caldwell, Dan: "From SALT to START: Limiting Strategic Nuclear Weapons," in Burns (ed.): *op. cit.*, vol. II, pp. 895-914; Karp, Regina Owen: "The START Treaty and the Future of Strategic Nuclear Arms Control," in SIPRI: *World Armaments and Disarmament. SIPRI Yearbook 1992* (Oxford: Oxford University Press, 1992), pp. 13-37; May, Michael, George F. Bing & John D. Steinbruner: "Strategic Arsenals after START: The Implications of Deep Cuts," *International Security*, vol. 13, no. 1 (1988), pp. 90-133. On the INF Treaty see Nolan, Janne E.: "The INF Treaty: Eliminating Intermediate-Range Nuclear Weapons," in Burns (ed.): *op. cit.*, vol. II, pp. 955-966; Dean, Jonathan: "The INF Treaty Negotiations," in SIPRI: *World Armaments and Disarmament. SIPRI Yearbook 1988* (Oxford: Oxford University Press, 1988), pp. 375-394.

⁴ Loeb, Benjamin S.: "Test Ban Proposals and Agreements: The 1950s to the Present," in Burns (ed.): *op. cit.*, vol. II, pp. 827-846; Carter: *op. cit.*, pp. 42-105.

⁵ Bunn, Matthew: "The Anti-Ballistic Missile Treaty: 1972 to the Present," in Burns (ed.): *op. cit.*, vol. II, pp. 915-928. On the negotiations, see e.g. Garthoff, Raymond: *Detente and Confrontation. American-Soviet Relations From Nixon to Reagan* (Washington, DC: The Brookings Institution, 1985), pp. 133-198. On the contents of the treaty, see e.g. Schwartz, David N.: "Past and Present: The Historical Legacy," in Ashton B. Carter & idem (eds.): *Ballistic Missile Defense* (Washington DC: The Brookings Institution, 1984), pp. 330-349; Schneiter, George: "The ABM Treaty Today," *ibid.*, pp. 221-250; Drell, Sidney, Philip J. Farley & David Holloway: "Preserving the ABM Treaty: A Critique of the Reagan Strategic Defence Initiative," in Steven Miller & Stephen Van Evera (eds.): *The Star Wars Controversy. An International Security Reader* (Princeton, NJ: Princeton University Press, 1986), pp. 57-97.

⁶ Lockwood, Dunbar: "Nuclear Arms Control," in SIPRI: *World Armaments and Disarmament. SIPRI Yearbook 1993* (Oxford: Oxford University Press, 1993), pp. 549-573. The treaty itself, with accompanying protocols and MOUs, is appended on pp. 576-589. The preceding "de-mirving" agreement of 17 June 1992, is excerpted *ibid.*, pp. 575-576. MIRVs were especially crisis unstable because they allowed one side to "take out" several enemy missiles (and even more warheads) with each missile in a first strike, while at the same time increasing vulnerability to a hostile first strike that might neutralize several launchers, with an even greater number of warheads. Both incentives for, and the actual ability to launch a (partially) disarming first strike were thus increased. On MIRV see also Greenwood, Ted: *Making the MIRV: A Study in Defense Decision Making* (Cambridge, MA: Ballinger, 1975).

⁷ Ramberg, Bennett: "The Seabed Treaty: 1971 to the Present," in Burns (ed.): op. cit., vol. II, pp. 887-894; Garthoff, Raymond: "The Outer Space Treaty: 1967 to the Present," *ibid.*, pp. 877-886; Joyner, Christopher J.: "The Antarctic State Treaty: 1959 to the Present," *ibid.*, pp. 817-826.

⁸ Stone, Webster A.: "The Hot Line: Washington-Moscow Direct Communications Link, 1963 to the Present," in Burns (ed.): op. cit., vol. II, pp. 847-854. On the "Agreement on the Prevention of Nuclear War" of 1973 see also Holgate, Laura S. Hayes: "Preventing Accidental War," *ibid.*, pp. 1093-1100. On various other measures see Blechman, Barry M.: "Efforts to Reduce the Risk of Accidental or Inadvertant War," in George & al. (eds.): op. cit., pp. 466-481.

⁹ On no-first-use see Hampson, Fen Osler: "'No-First-Use' Nuclear Policy," in Burns (ed.): op. cit., vol. II, pp. 1069-1078. See also Bundy, McGeorge, George F. Kennan, Robert S. McNamara & Gerard Smith: "Nuclear Weapons and the Atlantic Alliance," in William P. Bundy (ed.): *The Nuclear Controversy. A Foreign Affairs Reader* (New York: New American Library, 1985), pp. 23-40; Union of Concerned Scientists: *No-First-Use* (Washington, DC: UCS, 1983); Steinbruner, John D. & Leon V. Sigal (eds.): *Alliance Security: NATO and the No-First-Use Question* (Washington, DC: The Brookings Institution, 1983); Blackaby, Frank, Josef Goldblatt & Sverre Lodgaard (eds.): *No-First-Use* (London: Taylor & Francis, 1984); Lee, John Marshall: 'No First Use of Nuclear Weapons', in P. Terrence Hopmann, & Frank Barnaby (eds.): *Rethinking the Nuclear Weapons Dilemma in Europe* (New York: St. Martin's Press, 1988), pp. 73-85; Lübke, Eckhard: "Current NATO Strategy and No First Use: What Can They Accomplish?" *ibid.*, pp. 115-131. The ICJ (International Court of Justice) has, in an advisory opinion, proscribed the use of nuclear weapons. See Chazournes, Laurence Boisson de & Philippe Sands (eds.): *International Law, the International Court of Justice and Nuclear Weapons* (Cambridge: Cambridge University Press, 1999).

¹⁰ Tannenwald, Nina: "Stigmatizing the Bomb. Origins of the Nuclear Taboo," *International Security*, vol. 29, no. 4 (2005), pp. 5-49.

¹¹ Brodie, Bernard (ed.): *The Absolute Weapon* (New York: Harcourt Brace, 1946), p. 76.

¹² Rosenberg, David Allen: *idem*: "'A Smoking Radiating Ruin at the End of Two Hours'. Documents on American Plans for Nuclear War with the Soviet Union, 1954-1955", *International Security*, vol. 6, no. 3 (Winter 1981/82), pp. 3-38; "The Origins of Overkill: Nuclear Weapons and American Strategy, 1945-1960", *ibid.*, vol. 7, no. 4 (Spring 1983), pp. 3-71; Ball, Desmond: "The Development of SIOP, 1960-1983", in *idem* & Jeffrey Richelson (eds.): *Strategic Nuclear Targeting* (Ithaca, NY: Cornell University Press, 1986), pp. 57-83.

¹³ See, for instance, Wittner, Lawrence S.: *The Struggle Against the Bomb*, vol. 2: "Resisting the Bomb: A History of the World Nuclear Disarmament Movement, 1954-1970" (Cambridge: Cambridge University Press, 1997), *passim*.

¹⁴ McNamara, Robert S.: "The Military Role of Nuclear Weapons: Perceptions and Misperceptions", in Bundy (ed.): op. cit., pp. 77-98 (quote from p. 97).

¹⁵ Glaser, Charles L. & Steve Fetter: "Counterforce Revisited. Assessing the Nuclear Posture Review's New Missions," *International Security*, vol. 30, no. 2 (2005), pp. 84-126.

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¹⁷ Gavin, Francis J.: "Blasts from the Past. Proliferation Lessons from the 1960s," *International Security*, vol. 29, no. 3 (2004), pp. 100-135.

¹⁸ See, for instance, Iklé, Fred Charles & H. Speier: "The Diffusion of Nuclear Weapons to Additional Countries: The 'Nth Country' Problem," Report, no. AD0315618 (Santa Monica, CA: RAND, 1960); Brody, Richard A.: "Some Systemic Effects of the Spread of Nuclear Weapons Technology," *Journal of Conflict Resolution*, vol. 7, no. 4 (1963), pp. 663-753.

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²² See, for instance, Weissman, Steve & Herbert Krosney: *The Islamic Bomb. The Nuclear Threat to Israel and the Middle East* (New York: Times Books, 1981). For a critique see Falk, Richard: "False Universalism and the Geopolitics of Exclusion: the Case of Islam," *Third World Quarterly*, vol. 18, no. 1 (1997), pp. 7-23, especially p. 16.

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²⁵ On Taiwan see Yager, Joseph: "Taiwan," in idem (ed.): *Nonproliferation and U.S. Foreign Policy* (Washington, DC: Brookings, 1980), pp. 66-81; Kokoski, Richard: *Technology and the Proliferation of Nuclear Weapons* (Oxford: Oxford University Press, 1995), pp. 1, 70; Fischer, David, Wolfgang Köttner & Harald Müller: *Nuclear Non-Proliferation and Global Order* (Oxford: Oxford University Press, 1994), p. 44; Bailey, Kathleen C.: *Strengthening Nuclear Nonproliferation* (Boulder: Westview, 1993), p. 89; Mitchell Reiss & Robert S. Litwak: *Nuclear Proliferation after the Cold War* (Baltimore, MD: John Hopkins University Press, 1994), pp. 155-157. On the "nuclear history" of the ROK, and the linkage between US guarantees and abstention from nuclear ambitions, see O, Won Chol: "Nuclear Developments in Korea in the 1970s," *Pacific Research*, vol. 7, no. 4 (1994), pp. 11-18. See also Paul: *op. cit.*, pp. 120-124.

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⁹⁰ Data from IAEA: Nuclear Technology Review 2006, pp. 41-42.

⁹¹ Fig, op cit: 93-111.

⁹² Business Day 13.02.07.

⁹³ Business Day 21.02.07.

⁹⁴ Business Day 28.11.06.

⁹⁵ Business Day 23.06.06; 03.03.2007.

⁹⁶ Stockholm International Peace Research Institute: Yearbook 1996. (Oxford: Oxford University Press, 1993: 253-253.

⁹⁷ Business Day 04.09.2006.

⁹⁸ ANC Today 6(33), 25-31.08.2005.

⁹⁹ Economist 22.06.2006; Business Day 03.10.2006.