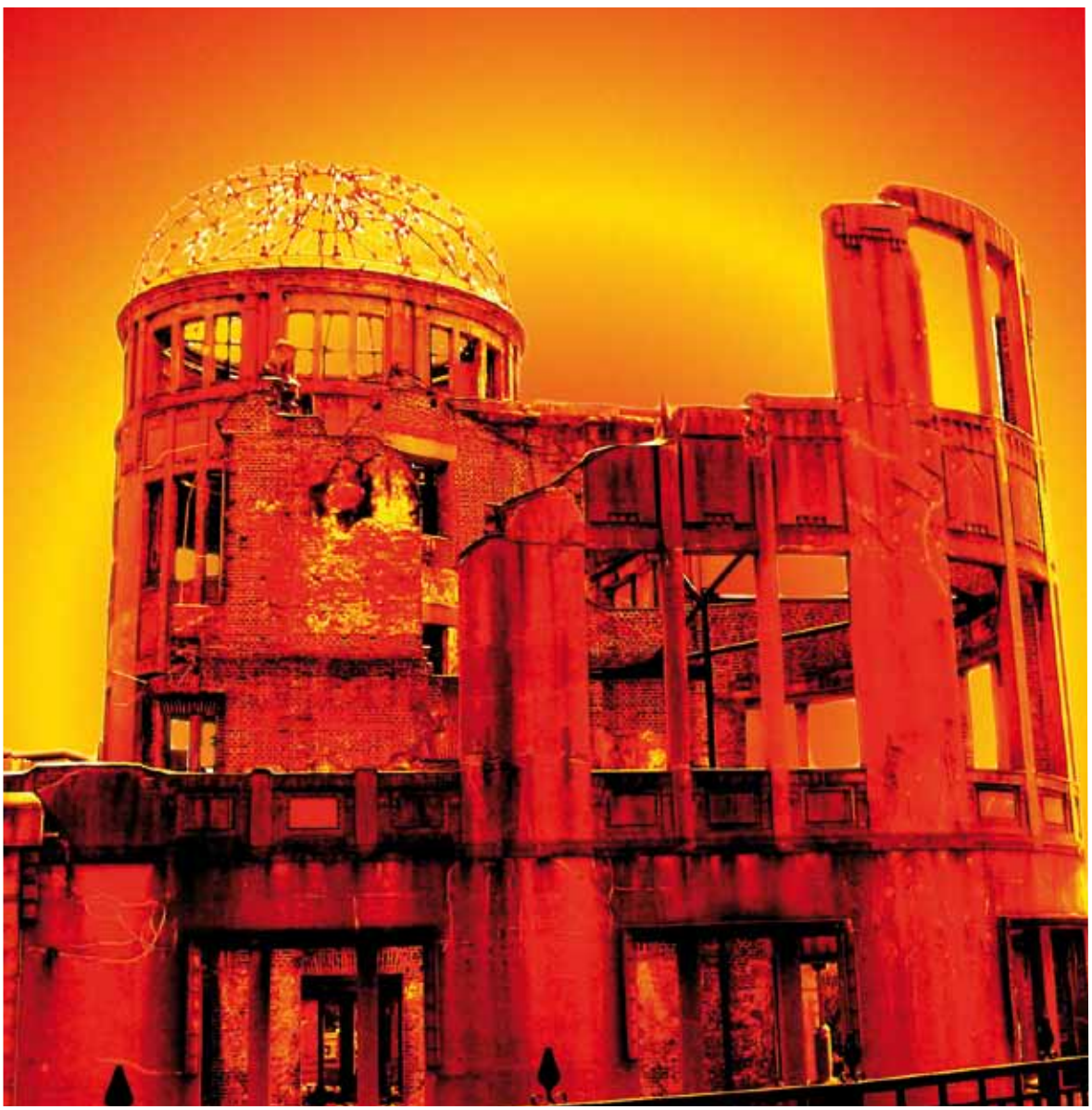
HEINRICH BÖLL STIFTUNG
ECOLOGY

GEF GREEN EUROPEAN FOUNDATION

NUCLEAR PROLIFERATION:
A CIVILIAN AND A MILITARY DILEMMA



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PREFACE: NUCLEAR ENERGY – A DEAD END

Anyone following the statements expressed from time to time about the renaissance of nuclear energy could get the impression that the number of new nuclear plants was increasing at an immense and steady rate. In fact, more recent statistics show 60 plants in the process of being built, the majority in China and others in Russia, India, South Korea and Japan. The USA is only shown as having one actual building project. However, this list (the VGB Power Tech) includes numerous ancient projects that were never completed and are therefore de facto building ruins.

Moreover, there are at the present time proposals for about 160 new nuclear power plants up to the year 2020, 53 of these in China alone and 35 in the USA, followed by South Korea and Russia. In Europe, the UK heads the list with eight proposed new projects, followed by Italy, Switzerland, Finland, Rumania and Lithuania. France, that would like to bless the world with new nuclear power stations, is itself only planning one new plant. Most European states are not entertaining any concrete nuclear plans.

As a matter of fact the number of nuclear power plants in the world is continually decreasing. At the present time there are still 436 reactors in operation. In the next 15 to 20 years more ageing plants will go offline than new ones coming into operation. By no means will all declarations of intent be implemented. The more energy markets are opened up to free competition, the smaller the chances are for nuclear energy.

The costs for new plants are also exploding. For example, the building cost of the new nuclear power plant in Finland's Olkiluoto has already increased from 3 to around 5.4 billion Euros although not even the shell of the building is standing yet. In addition, there are the unsolved problems of waste disposal and the high susceptibility of the technology to failure. Today, no privately run energy conglomerate risks building a new nuclear power station without government subsidies and guarantees. It is noticeable that new nuclear power stations are built particularly where the government and the energy industry form an unholy alliance.

Up to now, nuclear power plants have been funded by massive public subsidies. For Germany the calculations roughly add up to over 100 billion Euros and this preferential treatment is still going on today. As a result the billions set aside for the disposal of nuclear waste and the dismantling of nuclear power plants represent a tax-free manoeuvre for the companies. In addition the liability of the operators is limited to 2.5 billion Euros – a tiny proportion of the costs that would result from a medium-sized nuclear accident. All things considered nuclear energy proves to be just as expensive as it is risky.

In addition to the routine arguments about nuclear energy, there are some new ones. Firstly, the danger of nuclear proliferation is growing in proportion to the number of new nuclear power stations all over the world. There is no insurmountable division between the civil and military use of this technology in spite of the efforts on the part of the International Atomic Energy Agency (IAEA) to regulate this. The most recent example is Iran. At the end of the day anyone who does not want to be regulated cannot be forced to do so. With the expansion of nuclear energy there is a growing necessity to build reprocessing plants and fast breeders in order to produce nuclear fuel. Both give rise to the circulation of plutonium leading in turn to the creation of huge amounts of fissile material capable of making bombs – a horror scenario!

Secondly, an extension of the life span of existing nuclear energy stations, and even more so the building of new plants, would act as a massive brake on the development of renewable energies. The claim that nuclear energy and renewable energies complement each other is a myth since not only do they compete for a meagre amount of investment capital and power-lines but at the

same time nuclear plants limit the growth potential particularly of wind energy owing to their inflexible continuous operation. On windy and low-consumption days the energy demand in Germany is already covered to a large extent by the wind energy supply. As the output of existing nuclear power stations (as well as the big coal-fired power stations) is not reduced at short notice for economic reasons, the surplus energy has to be exported to other countries at a loss. There is method in this madness.

Whatever way you look at it, nuclear energy has neither the potential to make a decisive contribution to climate change nor is it necessary in order to guarantee energy supply. The exact opposite is true. Those who want to promote the development of renewable energy with the aim of producing 100% of the power demand should oppose the building of new nuclear plants as well as the life span extension of older ones. Despite the claims about nuclear energy it is not a suitable interim strategy leading towards the age of solar energy.

Berlin, January 2010
Ralf Fücks
(Chairman of the Heinrich-Böll-Stiftung)

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Nuclear Weapons and Nuclear Energy – Siamese Twins or Double Zero Solution?

By Otfried Nassauer

INTRODUCTION

As a nuclear power, as the only nuclear power to have used a nuclear weapon, the United States has a moral responsibility to act. (…). So today, I state clearly and with conviction America's commitment to seek the peace and security of a world without nuclear weapons. I'm not naive. This goal will not be reached quickly – perhaps not in my lifetime. It will take patience and persistence. But now we, too, must ignore the voices who tell us that the world cannot change. We have to insist, "Yes, we can." (…) together we will strengthen the Nuclear Non-Proliferation Treaty as a basis for cooperation. The basic bargain is sound: countries with nuclear weapons will move towards disarmament, countries without nuclear weapons will not acquire them, and all countries can access peaceful nuclear energy. (…) We must harness the power of nuclear energy on behalf of our efforts to combat climate change, and to advance peace opportunity for all people.[1]

Barack Obama in Prague, 05.04.2009

A year ago, U.S. President Barack Obama revived the vision of a world free of nuclear weapons. During a speech in Prague, he announced his commitment to achieving this aim and promised to use his time in office to take the first steps along the road to such a world and to seek progress with nuclear disarmament and improvements in the area of non-proliferation. One year later, the topic is once again setting the agenda for the American president. The following developments stood at the very forefront of public attention in April 2010:

- the signing of a new agreement for the reduction of strategic nuclear weapons between the USA and Russia (New START);
- the publishing of the Nuclear Posture Review, a report in which the U.S. Government must outline its future policy on nuclear weapons to the Congress;
- an international conference on the security of weapons-grade fissile materials to which the U.S. President had invited countries to attend in Washington;
- a conference of the NATO foreign ministers, where the future of nuclear weapons in NATO and in Europe would be discussed;
- and the next review conference for the Non-Proliferation Treaty.

In addition, there were attempts to impose stricter sanctions through the UN Security Council on Iran because of their nuclear programme.

The public debate about nuclear technology has, therefore, been determined by the following topics: the future of nuclear weapons, the continued reduction of their numbers and the future of nuclear non-proliferation. Another topic always accompanies discussions on the subject: the future of nuclear energy.

Moreover, this situation has not arisen by chance but because the military and civilian uses of nuclear technology are closely related or connected. Knowledge, materials and technology gained from the civilian use of nuclear technology can also be of use in a military nuclear programme. Therefore, comprehensive nuclear programmes – even when they are declared to be solely civilian – almost always evoke substantial proliferation fears. The debate about the nuclear programme in Iran that has been rumbling now for many years is a current example of this issue.

1 http://www.whitehouse.gov/the_press_office/Remarks-By-President-Barack-Obama-In-Prague-As-Delivered
The manuscript for this article was finalised in the middle of April 2010. All links to sources on the internet were last checked on 13.04.2010.

Driven by the world's growing energy demands, particularly for electrical energy, and efforts to battle an imminent catastrophic change in climate through a reduction in CO_2 emissions, the civilian utilisation of nuclear energy may well be about to undergo a renaissance in the coming decades. Barack Obama expressly alluded to its possible contribution to holding back climate change in his speech in Prague. He has since made state-funded credit to the tune of more than 50 billion dollars available as an incentive for the construction of new nuclear power plants. Its proponents argue that nuclear energy enables the production of large amounts of electrical energy without the production of CO_2 emissions at the same time. In terms of climate policy, this is certainly an incentive. Yet does this advantage balance out the security policy risks that are associated with the use – and particularly with the further proliferation – of nuclear energy? Is the use of nuclear energy in an ever increasing number of countries – even if it is for the purpose of climate policy – worth the associated proliferation risks? Or do the growing security risks outweigh the alleged climate benefits of such a policy?

Central elements of the civilian nuclear fuel cycle confront mankind with security risks that are characteristic of nuclear technology. Enrichment technology, for example, can be used for generating fuel for nuclear reactors but can also be used for the purpose of producing the materials from which a nuclear weapon is built. The difference in use is of a more gradual nature rather than fundamental. A number of types of reactor enable both the recovery of nuclear weapons-grade plutonium and the production of electricity. In reprocessing facilities, weapons-grade plutonium can be separated in the same way as reactor plutonium – the latter is not as useful for building nuclear weapons. Nuclear technologies, the associated know-how and nuclear materials can be proliferated. Nuclear experts can travel or migrate. The very existence of a wide range of specific export controls, reliability tests for employees and a special non-proliferation policy show that the danger of nuclear proliferation is to be taken seriously.

The following chapters will illustrate – without going into too much technical detail or specific examples – how closely civilian and military uses of nuclear technology are intertwined and interwoven. They are in fact similar to Siamese twins. As a result, there is a risk of proliferation of nuclear technology for military use. In the end, only the rejection of both uses of nuclear technology – a double zero solution[2] – is likely to allow the realisation of a world free of nuclear weapons because only under these conditions it can be guaranteed, controlled and monitored that no military use of nuclear technology is taking place.

2 A 'double zero solution' refers to the Intermediate-Range Nuclear Forces Treaty of 1987. This first nuclear disarmament treaty eliminated two classes of nuclear missiles from NATO stocks and those from the Warsaw pact: intermediate-range ballistic and cruise missiles. The signatory states of Russia and the USA are now no longer allowed to possess ground-launched missiles with a range of 500 to 5,500 kilometers.

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1. Non-proliferation efforts – a quick overview

During the Cold War period, proliferation fears were focused primarily on those countries that were suspected to have an interest in the materials, technology or knowledge required for nuclear weapons. In the 1960s and the early 1970s, these countries included, for example, the Federal Republic of Germany, India, Israel, Japan, Switzerland and Sweden. In the mid-1970s and the beginning of the 1980s, Argentina, Brazil, Egypt, India, Iran, Iraq, Pakistan, South Korea, Taiwan, and South Africa were amongst those countries whose nuclear ambitions were judged to be a cause for concern. Since the beginning of the 1990s, it has been primarily Iraq, Iran, Pakistan and North Korea. Almost all non-nuclear weapons states that have operated comprehensive nuclear research or nuclear energy programmes were viewed with suspicion at an early stage in the development of these programmes and closely examined with a focus on their nuclear intentions.

However, up until the end of the Cold War, the number of countries that actually acquired nuclear weapons remained surprisingly small: this situation can be mainly attributed to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). Further contributions were made by the efforts of the International Atomic Energy Agency, whose tasks include the monitoring of civilian nuclear facilities. In addition, there have been multilateral or national technology and export controls, the voluntary self-restraint of non-nuclear weapons states, security assurances from the nuclear powers and – when the danger of the military use of nuclear technology was regarded as being particularly serious – diplomatic pressure and sanctions imposed by the international community.

After the NPT had been signed, the five nuclear powers, the United States, Russia, the United Kingdom, France and China, were only joined by Israel, India and South Africa as new nuclear weapons states during the Cold War period. In the cases of India and Israel, the USA was already quite certain during the negotiations for the treaty that it would not be able to prevent these two countries from developing nuclear weapons. This view was proved to be correct a few years later. South Africa with its apartheid regime was, therefore, the only country where it was more or less a surprise that they managed to build nuclear weapons despite the existing non-proliferation regime during this period. It was not until after the end of the Cold War that Pakistan and – according to their own claims – North Korea

became the first non-nuclear members of the NPT regime to build nuclear weapons.

Triggered by the end of the Cold War, at the beginning of the 1990s, for a short period there existed some hope that nuclear disarmament and strengthened non-proliferation efforts could perhaps still free the world from the danger of nuclear destruction. The USA and Russia signed up in quick succession to contractually agreed reductions to their 'heavy throw' nuclear missiles Strategic Arms Reduction Treaty (START) and in the Presidential Nuclear Initiatives also to mutual, unilateral reductions in their tactical nuclear weapons. South Africa gave up its nuclear weapons at the end of apartheid. Belarus, Kazakhstan and the Ukraine agreed – when also put under pressure – to renounce their nuclear weapons inherited from the Soviet Union and to enter the NPT as non-nuclear members. Two other non-nuclear members signed up to the treaty were Brazil and Argentina – both had long been counted amongst those states feared to have military nuclear intentions. In 1995, it was possible to agree an open-ended extension to the NPT – initially only agreed for a period of 25 years – that was not tied to any conditions.

The situation has changed significantly in the meantime. Proliferation is once again seen by many governments as one of the greatest risks for international security. A variety of factors have contributed to this situation. The nuclear powers have not reduced their nuclear weapons arsenals as quickly as many non-nuclear weapons states had hoped and expected following the end of the Cold War. The nuclear powers speak more frequently of the need to modernise their nuclear arsenals and in this way clearly signal that they aim to hold on to their nuclear weapons for decades to come. The break-up of the Soviet Union and the resulting weakening of Russia brought new and serious concerns into the general consciousness: would the emerging and crisis-ridden successor states of the Soviet Union be able to provide sufficient security for the nuclear weapons, nuclear material, technology and expert knowledge in their territories? After the Gulf War in 1991, international inspectors also discovered a secret nuclear weapons programme in Iraq. In 1998, Pakistan – as already expected for some time – had to be added to the list of nuclear powers because it successfully tested nuclear weapons for the first time. Finally, after a long waiting game, North Korea became the first country to leave the NPT in 2003 and subsequently declared that it possessed nuclear weapons.

Since the 9/11 attacks, public awareness of the proliferation risks has been growing rapidly. The USA, as the victim of these terrorist attacks, added a whole new group of proliferation actors and recipients of proliferation to prominent positions in their security policy threat analysis: transnational non-state actors such as terrorists, organised criminals, religious extremists or transnational corporations. Although a number of experts had these actors on their radar already for a number of decades, it was only after the terror attacks on New York and Washington that politics and the wider public as a whole became recognisably worried by these groups. What if terrorists used a nuclear weapon or even only a dirty bomb made from radioactive materials and conventional explosives in a major terrorist attack in future?

A large proportion of this new attention can actually be traced back to politicians, think tanks and industry in the United States and elsewhere. These actors have tried extremely successfully to turn the threat of terrorism – especially terrorism with weapons of mass destruction – into sales arguments for their own products, services and interests, as well as to guarantee access to the appropriate financial resources. Under the George W. Bush administration they found ready and willing support.[3] Nevertheless, this much

3 Also under Barack Obama, who has elevated the prevention of nuclear terrorism to one of his priorities with the Nuclear Posture Review 2010, such structural patterns continue to be found right through to the world of academic study. cf. http://belfercenter.ksg.harvard.edu/files/al-qaeda-wmd-threat.pdf and as a criticism of this: http://sitrep.globalsecurity.org/articles/100126542-the-busted-watch-of-us-wmd-thr.htm

remains true: transnational non-state actors, such as terrorists, may indeed attempt to gain access to nuclear materials, technology or the relevant know-how. Should these groups actually plan to build, steal or acquire dirty, primitive or even elaborate nuclear explosive devices then merely the possibility of them achieving some success represents a serious problem.

As proliferation has once again found its way to the very top of the agenda in international security policies, those risks arising from civilian or military nuclear programmes are also gaining additional attention. The current debate about the Iranian nuclear programme is a good example: Iran is not only mistrusted because it has kept part of its nuclear technology secret and violated some of its obligations as a non-nuclear member of the NPT under the control of the IAEA, but also because of the experiences gained dealing with Iraq and North Korea. The Iraqi example made clear that it was possible for a country to press ahead with a military nuclear programme under the cloak of a civilian programme and hide it from IAEA safeguards. North Korea was also able to turn what was initially a 'civilian' nuclear programme into a military one. Although North Korea was suspected at an early stage and strict sanctions were imposed against the country later on, it reached the stage where the possibility of developing a functioning nuclear weapon was so close that North Korea was willing to risk withdrawing from the NPT and claim ownership of nuclear weapons. A few years later, North Korea demonstrated their willingness to undertake the country's first tests using nuclear explosives.[4] As a consequence, it is often argued that Iran must be prevented from becoming a 'second North Korea.' Even if the Iranian nuclear programme, as well as the country's intentions, were of an entirely civilian nature, as the government in Tehran claims, it would be necessary to mistrust Iran due to the experiences with North Korea. All new civilian nuclear programmes going beyond the operation of imported light-water reactors and having the aim of mastering large parts of the fuel cycle are met by a much higher level of scepticism than in the past. Iran is the first country to be confronted by this new political climate in non-proliferation policy. It could set a precedent for dealing with other states in the future who wish to enter into the comprehensive use of nuclear technology.

4 Most experts do not yet regard the North Korean test explosions as successful nuclear weapons tests.

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2. Civilian nuclear installations – a quick overview

According to data from the IAEA, 32 of the 193 countries in the world were operating a total of 438 commercial nuclear reactor blocks for the generation of electricity in 2009. A further 54 facilities were under construction last year. Five reactor blocks were shut down for reconditioning purposes.[5] The reactors currently in operation provided less than 5 % of the world's total energy requirements, although in 2007 they were still producing around 14 % of the world's available electricity.[6] The vast majority of all commercial nuclear reactors are operated by countries in the industrialised world. In 2008, the USA had 104 reactors, France 59, Japan 55, Russia 31 and Great Britain 19. Germany had 17 reactors, Canada 18 and the Ukraine 15. South Korea had 20 nuclear power plants, India 17 and China 11. Taiwan operates six; Argentina, Mexico, Pakistan and South Africa operate two facilities each.[7] New reactor blocks are being built primarily by China (21), Russia (9), India (6) and South Korea (6).[8] Iran has nearly completed its first reactor in Bushehr and plans to build further reactors. Most of the world's reactors are pressurised water reactors (264). There are also heavy-water reactors (44), boiling water reactors (94), light-water-

5 IAEA: Nuclear Power Reactors in the World, Reference Data Series No 2, 2009 Edition, Vienna, 2009, http://www-pub.iaea.org/MTCD/publications/PDF/RDS2-29_web.pdf
http://www.iaea.org/Publications/Documents/Infcircs/index.html
As well as monitoring nuclear non-proliferation in the military arena, the IAEA also has the task of promoting and supporting civilian use of nuclear technology. Therefore, it is not possible for the IAEA to provide a fundamental critical analysis of civilian use. The data that is provided by the organisation might also occasionally have a 'positive tint' due to its job definition. This becomes clear, for example, when the pessimistic forecasts from the IAEA about future use of nuclear energy appear to be consistently higher than the optimistic forecasts of the International Energy Agency or the U.S. Department of Energy. However, the IAEA data is issued on a regular basis and therefore available for comparison. The data is based on the information provided by the member states, as well as the findings from the IAEA about the worldwide monitoring of nuclear facilities. There is no other comparatively large and high quality data pool publically available elsewhere.

6 In 2004 it was still 16%. http://www.iaea.org/NewsCenter/News/2008/np2008.html

7 IAEA: Loc.cit., pp.10/11.

8 IAEA, loc.cit. updated through: http://www.iaea.org/cgi-bin/db.page.pl/pris.opercap.htm

cooled graphite-moderated reactors (16) and gas-cooled graphite-moderated reactors (18). The overwhelming majority of nuclear power plants use low-enriched uranium (LEU) that contains between two and 5 % U-235. Some facilities, such as a number of heavy-water reactors, can be operated using natural uranium. There are only two fast breeder reactors in operation to date.[9]

Most of the countries operating nuclear power plants do not possess a completely closed fuel cycle but either have just the reactors or additional individual facilities used in the fuel cycle. Therefore, these countries operate an open fuel cycle.[10] Closed fuel cycles are operated, in particular, by those countries that have or used to have a nuclear weapons programme or otherwise have the ability to build such a programme. The largest nuclear weapon country, the USA, has an open civilian fuel cycle because its government decided in 1980 to dispense with the reprocessing of spent civilian fuel elements from nuclear reactors. The uranium[11] used as fuel in these reactors comes from two major sources. Almost two-thirds comes from uranium mines, currently located in 19 countries producing between 40,000 and 50,000 tonnes of natural uranium per year. The biggest suppliers are Canada, Australia and Kazakhstan. They jointly provided almost 60 % of the newly mined uranium in 2007. Other major suppliers are Nigeria, Russia, Namibia and Uzbekistan.[12] Iran has also been mining uranium for its own needs for a number of years. Back in 2003, 46 % of the global uranium supply for civilian reactors came from secondary sources such as the re-enrichment of depleted uranium, the reprocessing of spent fuel, and the downgrading of highly enriched uranium (HEU) from former military stocks. However, today the figure is only a little more than 30 %.[13] How high the proportion of secondary supply sources will be in the future is unclear. It is dependent, for example, on whether the nuclear weapons states continue to provide HEU from military stocks for 'downblending'[14] in future or if the worldwide reprocessing capacities are increased significantly.

At current rates of consumption the IAEA and the Organisation for Economic Cooperation and Development expect that the demand for uranium can be met through known deposits for another 83 years. The figure will be correspondingly shorter should there be increased consumption.[15] The OECD, which expects an increase in demand for newly mined uranium from 2020, lists a total of 43 countries possessing exploitable uranium resources. Both organisations anticipate that the use of nuclear energy will significantly increase.

Uranium enrichment can be achieved by using different technologies. The most common technology is enrichment with the help of gas

9 IAEA, Loc cit. p.61.

10 A closed fuel cycle is a cycle in which reactor fuel is produced out of natural uranium, fed into the reactor, then 'burned' in the reactor and afterwards is beeing reprocessed for use as new nuclear fuel. An open fuel cycle exists when the fuel passes through the reactor only once. The spent fuel elements are not reprocessed afterwards but stored instead.

11 A great deal of useful information about uranium, the fuel cycle and uranium processing facilities across the world can be found on the internet site of the uranium project from WISE. cf. www.wise-uranium.org

12 http://www.iaea.org/Publications/Reports/Anrep2008/fuelcycle.pdf
The data is based on the so-called Red Book, which the IAEA and the OECD publish every two years. The source named above is based on the 2008 edition because the new 2010 edition has not yet been published. Data from the 'Red Books' is also available online in a good, regularly updated form at: http://www.wise-uranium.org/umaps.html

13 Ibid.

14 'Downblending' - in simple terms – is when highly enriched uranium is mixed with other uranium until it becomes low-enriched uranium.

15 In their optimistic forecasts before the financial crisis in 2008, the IAEA anticipated that electricity production through nuclear reactors could be doubled from 372 GW(e) in 2008 to 748 GW(e) by 2030. A massive increase in the construction of new reactors is expected. cf. Ibid. p. 26 The IAEA's second role of promoting the use of nuclear energy is reflected in such optimistic scenarios for the future of nuclear energy, as well as in the ever more optimistic statements regarding the economically recoverable uranium reserves and, therefore, about the perspectives for available nuclear fuel.

centrifuges. Gaseous diffusion, electromagnetic isotope separation and the so-called Becker Process are other techniques used. The five traditional nuclear powers, the United States, Russia, the United Kingdom, France and China, operate enrichment facilities for civilian purposes and have also operated these types of facilities for military uses.[16] Pakistan also carries out the enrichment process for both military and civilian purposes.[17] Germany, the Netherlands, Japan, and South Africa operate commercial enrichment facilities for civilian purposes. Laboratory research as well as testing or smaller enrichment facilities are found in countries such as Australia and South Korea. Iran is currently involved in developing its uranium enrichment capabilities, consisting of a number of different facilities which are suspected to be used in future to serve a military nuclear programme.[18] North Korea is suspected of having an undeclared enrichment programme for military purposes. In May 2006, Brazil started operating their first centrifuges in a small commercial uranium enrichment facility, configured in such a way that it can enrich uranium up to a level of 5%; the facility is, however, capable of being converted to the production of highly enriched uranium. There has been conflict with the IAEA, who monitor the facility, about the extent to which Brazil must guarantee the organisation access to the technology used for the centrifuges operated there.[19] The facility has been operating in the trial phase since 2009.

Spent fuel that has been used in reactors can either be stored for a long period[20] or reprocessed in commercially operated facilities in Great Britain, France and Russia. Since 2008, Japan has become the first non-nuclear state to operate a commercial reprocessing facility.[21]

Reprocessing facilities use a modern version of the PUREX process, which enables, amongst other things, uranium to be recycled from the spent fuel elements and the separation of the reactor plutonium created in the process. Military reprocessing facilities for the separation of plutonium for nuclear weapons do not only exist in the five recognised nuclear weapons states but also in Israel, India, Pakistan and North Korea.

Some countries that operate civilian nuclear power stations, such as Germany, Belgium, Switzerland and the Netherlands, send their spent nuclear fuel abroad for reprocessing. The reactor plutonium that is separated in the process is either sent back, temporarily stored in trust or sent to another facility to be converted into mixed oxide fuel (MOX). Separated reactor plutonium is stored by a number of developed nations either on their own territory and/or on the territories

16 China, France, Great Britain, Russia and the USA no longer carry out the enrichment of uranium for military purposes.

17 India and Israel established test programmes for enrichment; their nuclear weapons were, however, created based on plutonium.

18 Iran initially built a testing facility that has since been used to test three different types of centrifuge. A larger enrichment facility is currently in the construction phase in which up to 50,000 centrifuges will be operated. Several thousand centrifuges have already been used there to enrich uranium to less than 5%. In the future, uranium will be enriched here to 20% in order to provide fuel for an Iranian research reactor. In addition, Iran has announced its intention to build up to 10 further smaller facilities, one of which is currently under construction. It is unclear in view of the fierce debate surrounding the Iranian nuclear programme whether the construction of numerous smaller facilities, which actually makes neither economic nor technical sense, is due to Tehran's desire to make the destruction of their nuclear facilities through air strikes more difficult.

19 Brazil is allegedly worried about industrial espionage because it wants to develop centrifuges that will be able to enrich uranium significantly more efficiently and less expensively. It argues that the IAEA can perform its monitoring activities without having to know all of the technical details about the centrifuge technology.
cf. http://www.giga-hamburg.de/dl/download.php?d=/content/publikationen/pdf/gf_lateinamerika_0606.pdf
For the current situation cf. http://www.swp-berlin.org/common/get_document.php?asset_id=6948

20 The fuel cycle remains open and the process is called 'once through'.

21 cf. http://www.sckcen.be
The reprocessing facility in Rokasho-Mura can process 800 tonnes of fuel per year. To prevent the risk of proliferation, the separated plutonium will be converted on-site into mixed oxide (MOX).

of countries reprocessing spent fuel for them.[22] Storage in non-nuclear weapons states is subject to the 'safeguards' of the IAEA.[23] This also applies to facilities for MOX production. Nuclear facilities in the nuclear weapons states are only subject to international monitoring when the country in question expressly agrees to it. Most developing countries that operate nuclear power plants do not carry out reprocessing. Instead, their spent fuel is kept in storage or sent back to the supplying country. Spent fuel makes up the majority of the reactor plutonium that currently exists in the world. Without making a decision about what will happen to this highly radioactive and dangerous waste material in the future, it is difficult to assess for certain whether this constitutes a new type of long-term proliferation risk.

Belgium, France, Great Britain, India and Japan produce commercial MOX fuel. On the one hand, the use of MOX enables a limitation of the stocks of separated reactor plutonium; while on the other hand, it allows additional plutonium to find its way into the fuel cycle. Countries using this type of fuel include Belgium, Germany,[24] Sweden and Switzerland. China is known to be considering its use. Japan and Russia intend to operate fast breeder reactors using MOX in future. Germany planned at one time to use large-scale MOX production but has since dismantled both the pilot facilities and the commercial facilities for MOX production. Russia and the USA are entering into the production of MOX to reduce their stocks of weapons-grade plutonium.

HEU fuel was still used in around 130 research reactors in 2004 and the figure has remained approximately the same up to 2010.[25] This includes the only German research reactor Garching II,[26] which is currently operated with uranium enriched up to 93%. The use of HEU fuel in such reactors has caused security and proliferation fears for some time because HEU is relatively easy to handle with comparatively limited risks and many research reactors do not have elaborate security systems. Substantial amounts of used HEU fuel are also still stored in or near to shutdown research reactors. More than half of the approximately 380 decommissioned reactors up to 2004 had not been completely deconstructed up to this point in time.[27]

22 Because the available reprocessing facilities only process around one third of all spent fuel elements each year and the available MOX facilities have an even lower capacity, the overwhelming amount of reactor plutonium is present in the form of temporarily stored fuel elements. This amount continues to grow, together with the levels of separated and stored reactor plutonium.

23 In the EURATOM member states, EURATOM carries out the safeguard measures in civilian nuclear facilities and not IAEA. Therefore, these countries carry out self-regulation through multilateral cooperation.

24 The prerequisite for the use of this method for disposing of plutonium is the existence of operational light-water reactors or fast breeder reactors suitable for MOX. The remaining operational life of the German reactors suitable for MOX is unlikely to be sufficient to completely use up the already available reactor plutonium by the time of the politically agreed withdrawal from the nuclear energy programme, meaning that additional possibilities and technologies for final storage must be examined.

25 cf. http://www.iaea.org/NewsCenter/Features/ResearchReactors/security20040308.html
Current data about the status of individual research reactors is offered by the IAEA here:
http://www.iaea.org/worldatom/rrdb/
There appears to be a similar number (about 130) in operation in 2010. cf. the discussion about the number of research reactors in: Matthew Bunn: Managing the Atom 2010, Harvard University/Nuclear Threat Initiative, April 2010, pp. 43/44. cf. http://www.nti.org/e_research/Securing_The_Bomb_2010.pdf

26 Against the specific requests of the USA the Garching II reactor has been operated since 2004 with up to 93% uranium that has been imported from Russia. During 2010, the reactor should – where technically possible – be converted. As no alternative fuel is currently available that allows a comparatively intense neutron source, the reactor will continue to be operated using HEU. Research continues to be carried out with a uranium-molybdenum fuel with a lower enrichment level (up to 60%). It is now assumed that this will, if possible, be put into use around the end of the decade for the first time.

27 cf. http://www.iaea.org/NewsCenter/Features/ResearchReactors/security20040308.html
Current data about the status of individual research reactors is offered by the IAEA here:
http://www.iaea.org/worldatom/rrdb/

The most important elements of civilian fuel cycles contributing to proliferation are:

- technologies and facilities to enrich uranium;
- HEU fuel for research and naval reactors;
- research reactors and nuclear power plants capable of producing plutonium;
- reprocessing plants allowing separation of plutonium and the technologies used in such facilities;
- storage facilities for separated military plutonium and reactor plutonium, as well as for highly enriched uranium;
- research and processing facilities for the production of other materials suitable for nuclear weapons, such as tritium or polonium-210.

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3. States as a proliferation risk

The proliferation risks of civilian nuclear fuel cycles can be divided into two groups. The first group contains risks originating from a loss of control within a civilian nuclear programme. Nuclear materials, technology or know-how can be stolen and transferred abroad to support a nuclear weapons programme in another country. Abdul Q. Kahn's theft of centrifuge technology for uranium enrichment from Urenco (Uranium Enrichment Company) in the Netherlands in 1974 is the best-known example. His network's later activities in supplying Iran, Libya and North Korea with nuclear know-how, technology and materials, show how a recipient of proliferation can also become a proliferator.[28] In addition: not only nuclear materials, technology and know-how can 'migrate', but also well-trained specialist personnel (the keyword here is "brain drain"). The different types of proliferation risk can not only occur individually but also in combination with each other.

The second form of proliferation risk is based on the same components: nuclear materials, nuclear technology, know-how and specialists. An existing civilian nuclear programme can be used to additionally develop a nuclear weapons programme. In this case, a state follows the military nuclear option and uses mainly its national supply sources. Only those resources that are not available in their own countries and therefore cannot be manufactured are imported.

To develop the ability to build nuclear weapons the interested parties can follow two different paths. They can try to build either a uranium or a plutonium-based weapon. In both cases, they need a significant amount of fissile material. The

28 cf. Egmont R. Koch: Atombomben für Al Qaida (Atom Bombs for Al Qaida), Berlin 2005.

IAEA surmises that 25 kg of highly enriched uranium (HEU, containing 90 % or more U-235) or eight kg of plutonium is the minimum amount required to build a simple but functioning nuclear weapon.[29]

Countries who have built nuclear weapons of both types are the United States, the Soviet Union, Great Britain, France, China and Pakistan. Israel, India and possibly North Korea have built their first nuclear weapons following the plutonium path. The only country which exclusively used uranium to successfully build a first nuclear weapon was South Africa. Iran has been accused of wanting to also follow this path.

Plutonium is a by-product that is created through the irradiation of uranium in different types of reactors. Depending on the reactor type and the length of time the nuclear fuel is irradiated there, different amounts of weapons-grade plutonium (it contains more than 95 % of the fissile isotope Pu 239 and Pu 241) and/or reactor plutonium (containing 'only' around 67 % of these isotopes) can be produced. In principle, both can be used to build weapons, although the reactor plutonium to a 'lesser' extent. The plutonium needs to be separated from the irradiated reactor fuel in chemical reprocessing facilities before it can be used for building a nuclear bomb. In contrast, HEU is produced in enrichment facilities using different technologies. Centrifuge enrichment has become the most commonly used method today.

The programmes for building nuclear weapons can be divided into two categories. Firstly, there are the nuclear programmes which had a military purpose from the outset. The United States, Great Britain, the Soviet Union and China acquired their nuclear weapons in this way. Secondly, there are those that started out with civilian programmes and the military aspect was either implicitly pursued from the very beginning or came along later in a concealed fashion. In the early phases of civilian nuclear programmes, it is often difficult to judge whether it is serving military or exclusively civilians goals. Countries that seemingly started their nuclear weapons programmes under a civilian guise include, for example, France, India, Israel, North Korea, and South Africa.

Depending on which path countries take in gaining the ability to build nuclear weapons, their requirement for individual facilities used in the fuel cycle is defined in their own countries. A country that wants to build a uranium weapon will require an enrichment facility, but not necessarily a reprocessing plant with the possibility for isolating plutonium. It will also not necessarily be on the lookout for reactor types that are particularly well suited for producing weapons-grade plutonium such as heavy-water reactors. In contrast, countries who want to build a plutonium weapon are more likely to develop these sorts of reactors and reprocessing facilities, while they will not necessarily want a facility for uranium enrichment because they can gain the plutonium required from suitable reactors e.g. even from natural uranium. Therefore, countries who want to develop a nuclear weapon capability using only one of the two paths can limit themselves to operating an open fuel cycle, while countries trying to keep both options open will mainly focus on a closed fuel cycle. In the past, many countries have tried to develop both paths or to keep the option open.

Shortly after the United States introduced the "Atoms for Peace" programme for civilian nuclear cooperation, concerns were expressed

29 All experts agree that these amounts are far too large if an actor has access to the modern technology for building an advanced nuclear explosive device. 4 kg is considered sufficient for a plutonium device. The U.S. State Department also works on the basis of this amount, as it reported on the occasion of the Nuclear Security Summit in Washington in 2010 that the USA and Russia had agreed a new protocol that expanded an existing agreement about the future non-military use of 34 tonnes of plutonium per country that is superfluous for military use. The total 68 tonnes of plutonium is an amount equivalent for 17,000 nuclear warheads, according to the press release from 13.04.2010. (cf. http://www.state.gov/r/pa/prs/ps/2010/04/140097.htm).

that nuclear technology could become too widely distributed and provide too many countries with the opportunity to seek the development of nuclear weapons. In 1963, the U.S. Ministry of Defense headed by Robert McNamara estimated that eleven additional countries could acquire nuclear weapons within a decade and many more shortly thereafter. As the Non-Proliferation Treaty was negotiated in the second half of the 1960s, the goal was to prevent a situation developing where the world had 20 or 30 nuclear powers – an argument used in justifying the need for the treaty that is equally popular today.

In view of the numerous national nuclear programmes with a civilian, but also potentially a military objective, the Non-Proliferation Treaty in combination with the controls of the IAEA, the export control regime of the Nuclear Suppliers Group[30] and the Zangger Committee,[31] as well as the use of diplomatic pressure and security policy guarantees, has proved itself to be surprisingly effective. Alongside Israel and India who had already resolved to build nuclear weapons at the time the Non-Proliferation Treaty came into force, only South Africa,[32] Pakistan and possibly North Korea have managed to develop nuclear weapons to date.

The national and international efforts used so far to keep further countries[33] from building nuclear weapons make it clear that this is no easy task. Although the risk of proliferation has been stemmed, it has not been possible to remove it altogether. The discovery of the secret nuclear programme in Iraq and the experience gained with North Korea show that an improved monitoring regime will be required in the future if the non-proliferation regime is to retain its proliferation inhibiting effect. The experiences gained from successful and controlled military nuclear programmes show:

- **firstly:** the important proliferation risks are currently found in the area of technologies for uranium enrichment, reprocessing and plutonium separation, production of plutonium and HEU powered reactors.
- **secondly:** civilian nuclear programmes repeatedly played a role in proliferation both as a cover up and as support to military programmes. They make it particularly difficult to judge a country's real intentions.
- **thirdly:** the security and export controls developed in the 1960s and 1970s, and further developed to a limited extent in the 1990s are insufficient today to adequately prevent a country's transition from a civilian to a military nuclear programme.
- **fourthly:** all countries that pursue nuclear activities train personnel over time and possess the technical abilities that allow them to rely increasingly on their domestic capabilities and less on help from the outside world. Technological progress contributes to this development as more and more countries can produce nuclear related equipment to standards that only industrialised countries could meet in earlier decades.
- **fifthly:** the concept of preventing the proliferation of nuclear technology for military purposes while promoting the civilian use of nuclear energy finds itself in a deepening crisis.

30 The group of most important countries for the supply of nuclear materials and technology – currently 45 countries.
31 The Zangger Committee, established by the IAEA, has developed lists of fissile materials and nuclear relevant goods since 1974 whose export requires safeguards being applied in the recipient countries.
32 South Africa gave up its nuclear weapons later.
33 Information about national nuclear programmes: http://www.globalsecurity.org/wmd/world/index.html; http://www.nti.org/e_research/profiles/index.html

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4. Non-state actor risks

Non-state actors were already considered a major proliferation and security concern as early as the late 1960s. Experts understood that it was possible to build a crude nuclear weapon on the basis of publicly accessible information.[34] In 1975, a study by the CIA stated: "The possibility of terrorists getting hold of nuclear weapons poses the most severe limitation on political efforts to manage proliferation. This is the most puzzling and extreme aspect of the potential diversification of nuclear actors. The same increasing availability of nuclear materials and technology which made nuclear explosives accessible to developing states can also be expected sooner or later to bring them within the reach of terrorist groups. (...) Because nuclear terrorists would, by definition, operate outside of official governmental processes, they are largely immune to international political controls. IAEA safeguards, for example, do not include any provisions against terrorists stealing materials from a reactor complex."[35]

Since the disintegration of the Soviet Union, this concern has been articulated more loudly in public. In view of the huge nuclear infrastructure there the fear grew that massive proliferation risks could result from these developments. While the authoritarian Soviet Union had kept its nuclear material, know-how and technicians under the strictest of control – closed cities, rigid travel restrictions and surveillance by the military and the KGB – it seemed unlikely that these measures would remain effective after the break-up of the Soviet Union or that the successor states of the Soviet Union would be able to maintain them. Therefore, a considerably greater level of attention has been given since 1991 to the dangers arising from the possibility that nuclear materials, technologies or even complete warheads could fall into the hands of terrorists or organised criminals.[36]

34 University of California, Lawrence Radiation Laboratory: Summary Report of the Nth Country Experiment, UCLR 50249, Livermore, CA, March 1967 (original classification: SECRET, partially released under FOIA, 4.1.1995).

35 Central Intelligence Agency: Managing Nuclear Proliferation: The Politics of Limited Choice. Research Study. Langley VA, 1975 (original classification SECRET/NOFORN, partially declassified 21.8.2001), p. 29.

36 cf. Siegfried Fischer, Otfried Nassauer (Hg): Die Satansfaust, Berlin 1993, P. 315ff. Graham T. Allison et al.: Avoiding Nuclear Anarchy, Containing the Threat of Loose Russian Nuclear Weapons and Fissile Material, Cambridge/London 1996. Jessica Stern: The Ultimate Terrorists, Cambridge/London 1999.

4.1 Nuclear weapons in terrorist hands

In theory, terrorists could also obtain nuclear weapons. They would have to either build, purchase, steal or receive them as a gift. If it was their intention to build a nuclear weapon then they would have to try to produce, purchase or steal the required materials.[37] To produce the materials themselves they would be faced with the same difficulties as a state trying to become a nuclear power. Since non-state actors are not countries with their own territory, they would need a state to host them and the necessary infrastructure, whose cooperation was provided either willingly or because the state is not able to completely control its territory. There are large obstacles on this path to building a nuclear weapon. Even if a terrorist group could obtain the necessary fissile nuclear materials by buying or stealing them, they would still need a weapons design, working precision fuses, and several other components that are difficult to source. It is rather unlikely that terrorists would manage to quickly overcome the diverse nature of these problems. Thus the option that terrorist groups could try to produce a nuclear bomb from materials which they themselves have produced is currently rather remote. Terrorists would be most likely to succeed if they cooperated with a state (or its intelligence services) that already has either nuclear weapons or weapons-grade nuclear materials. Access to nuclear know-how and the cooperation with well-trained nuclear personnel could also make this task easier for terrorists. However, if a nuclear power was already prepared to work closely together with a terrorist organisation then this raises a further question: why would that state not be willing to hand over a complete weapon to the terrorist organisation in the first place?[38]

Terrorists finding themselves in the possession of a real nuclear weapon would represent an enormous danger. However, the experts are largely in agreement that the likelihood of terrorists possessing a functioning nuclear weapon or being able to get hold of one is relatively low.

4.2 Dirty bombs in terrorist hands

A scenario in which terrorists or organised criminals could build and use a dirty nuclear bomb is more likely. A dirty bomb contains radioactive material which is spread by using a conventional explosive device. No uncontrolled chain reaction is involved. One could imagine a conventional car bomb mixed with a few dozen or a hundred grams of a radioactive substance. There would be injuries and deaths as a result of the explosion, as well as radioactive contamination in the area surrounding the site of the detonation; the main effect of a dirty bomb however would be psychological.[39] A simulation, which investigated the effects of an explosion involving a dirty bomb containing two tonnes of explosive in central Washington DC, concluded that an area the size of one block would suffer severe and possibly even permanent damage. Other simulations concluded that the damage would stretch to multiple blocks of buildings or even a whole district.

However, a major obstacle to building such a weapon results from the difficulties in handling the radioactive material involved. Since the effect of such a weapon – alongside the immediate effect

37 HEU operated research facilities and their reserves of not yet irradiated HEU are therefore regarded as an important security risk.

38 The risk that the role of the state providing nuclear materials and know-how to terrorists can be proven would, in view of the possibilities of modern nuclear forensics, only be insignificantly smaller than the risk that it could be proven that they have provided terrorists with a nuclear weapon. Nuclear forensics makes it possible to determine the facility in which the nuclear material used was produced or processed.

39 The explosion of a dirty bomb in a comparatively well-secured economic and political decision-making centre would create serious doubts about the capabilities of the government and state authorities to be able to fulfill one of their most important tasks: guaranteeing the safety of its people. In addition, the result – independent of the actual limited damage – would be to evoke an enormous level of insecurity because radioactive contamination is not perceptible but can still be highly dangerous.

of the explosion – is considerably dependent on the radioactivity and the toxicity of the materials used, the radioactive material presents a correspondingly high risk for those who build, handle or use the bomb. The level of danger faced by terrorists increases to the same degree as the radioactive and/or toxic effectiveness of the weapon they want to build. This is probably amongst the main reasons why no dirty nuclear weapon has yet been used.

It is relatively unlikely that terrorists would use radioactive material taken from one of the facilities used in a civilian nuclear fuel cycle for building such a bomb. Procuring the materials is not always easy; handling is often relatively difficult and in most cases highly dangerous. There are a variety of other materials that are much easier to acquire and which are equally as suitable for the requirements of a dirty bomb or perhaps even significantly better than low-enriched uranium, HEU or even reactor plutonium. Radioactive material like caesium 137, cobalt 60, strontium 90, crypton 85 or americum 241 is significantly easier to get hold of and better suited for the purpose because they are used widely in civilian life within for example hospitals, industry, material and leakage testing or in smoke alarms.

4.3 Nuclear materials smuggling

Since the disintegration of the Soviet Union, there have been reports about a large number of cases of lost and found nuclear materials and corresponding cases of smuggling. Ordinary criminals, members of organised crime, terrorists and also intelligence services and police authorities have shown a great interest in this topic – as well as the media. This has made it difficult to differentiate between actual attempts to conduct illegal trafficking, fraudulent and decoy operations or cases of nuclear smuggling that were misreported. Analysing media reports does not tell us much about the real relevance of smuggling for nuclear proliferation. A more reliable source for an assessment of illegal nuclear trade is the illicit trafficking database established by the IAEA in 1995. Over 650 incidents were officially confirmed by the agency between 1993 and 2004. More than 60 % of the incidents involved non-fissile radioactive materials, such as caesium-137, strontium-90, cobald-60, or americium-241. Most of these materials raise concerns because of their possible use in terrorist or criminal operations, since they could be used in radioactive dispersal devices or a dirty bomb. Around 30 % of all cases involved nuclear materials such as natural uranium, depleted uranium, thorium and LEU.

However, weapons-grade nuclear material was present in 18 cases. These are the most important cases from a proliferation standpoint. Seven incidents involved plutonium, six of these in quantities of less than one gram up to 10 grams. The seventh incident, involving more than 363.4 grams of plutonium, occurred at Munich Airport in August 1994. The case involved both the Russian authorities and German intelligence.[40] Eleven cases involved highly enriched uranium in quantities of less than one gram up to more than 2.5 kilograms. In most of these incidents, samples for larger follow-up deals seem to have been seized.[41] The number of confirmed cases of

40 After the magazine 'Der Spiegel' had printed the case as a title story in August 1994 (cf. http://www.spiegel.de/spiegel/print/index-1994-34.html), the magazine reported in April 1995 the development of the BND /Federal Intelligence Service) under the title "Panic made in Pullach".
cf. http://www.spiegel.de/spiegel/print/d-9181696.html. The German Parliament set up an inquiry to investigate the case.
cf. http://dipbt.bundestag.de/dip21/btd/13/013/1301323.asc.

41 The IAEA provided a detailed overview of such cases in the past up until 2004 at http://www.iaea.org/NewsCenter/Features/RadSources/Fact_Figures.html. This list is no longer available. Important parts of comparable data can be found today at: http://www.iaea.org/NewsCenter/Features/RadSources/PDF/fact_figures2005.pdf
The figures for 2004 are taken from these sources.
A current representation of the situation from 2009 containing information that is not directly comparable can be viewed at: http://www-ns.iaea.org/downloads/security/itdb-fact-sheet-2009.pdf
The figures are not directly comparable because firstly, the reporting method used for the database was changed from 2006 and secondly, because the number of states reporting incidents has risen over the years to 192.
The latest information contained in this paragraph comes from the source named above.

unauthorised possession, loss or theft and other illegal incidents involving nuclear materials had risen by the end of 2008 to 1562 cases. Plutonium or highly enriched uranium was involved in 15 of these cases. Most of them involved small amounts, although in a few cases the amounts were in kilograms. The IAEA no longer reports the details of these cases but acknowledges that the majority of well-known cases were 'supply cases' in which no purchaser was found. Naturally, the possibility that there have been successful cases of nuclear smuggling and illegal nuclear trafficking that have not been discovered or reported must be taken into account.

4.4 Non-state actors and fuel cycle safety

Terrorists might indeed pose severe risks to the security of civilian nuclear installations. However, there is no known systematic public study into these dangers. Some spotlights have been directed at individual parts of the problem. In the 1990s, the United States simulated 75 attacks on some of their own reactors. The results showed some serious deficiencies in security. In 27 cases, the attacks could have led to damage to the reactor core and the release of radiation.[42] Greenpeace succeeded in breaking into the British nuclear power plant Sizewell in 2003, without meeting any resistance.[43] Research reactors at universities, which are operated using highly enriched uranium, are a particularly serious problem because a large number of people often require access to them and these facilities have comparatively limited security measures in place.

When serious security problems occur in industrialised countries who have the resources and capacity available to invest in the security of these sensitive areas of infrastructure, then it can be assumed that in those countries with more limited financial power a significantly greater risk exists that nuclear materials from reactors, laboratories and nuclear facilities will go missing.

The risks posed by terrorist attacks on such facilities must also not be ignored. They could lead to the release of huge amounts of radioactive material, although not to a nuclear explosion. The likelihood of a terrorist attack on civilian nuclear facilities must be regarded as significantly higher than that of nuclear weapons falling into terrorist hands and it is also likely that it is higher than the risk of the use of a dirty bomb. The fact that there have been discussions about the protection of reactor blocks from attacks using aircraft in recent years shows that people are slowly beginning to take this problem seriously.

4.5 Other proliferation risks

In 1977, it became known that the U.S. Department of Energy had already successfully carried out an underground test with a nuclear weapon that had been made from reactor plutonium back in 1962. This made it evidently clear that it was possible in principle to build nuclear weapons from 'civilian' sources – namely from reactor plutonium. A study conducted at the Los Alamos National Laboratories came to the conclusion in 1990 that states terrorist groups who attempted to build nuclear weapons from reactor plutonium would face difficulties differing to those faced by groups with access to weapons-grade plutonium only in their degree but not in their essence.[44]

The 2003 war against Iraq revealed another considerable proliferation risk: while U.S. troops were occupying Iraq they did not properly protect the main nuclear research facility in the country from being looted. IAEA seals in the facility were broken, nuclear material was lost and docu-

42 Union of Concerned Scientists: Backgrounder on Nuclear Reactor Security, Cambridge (MA) 2002.

43 Greenpeace UK: Greenpeace Volunteers Get into Top Security Nuclear Control Centre, Press release, London 13.01.2003. Also in: *Daily Mirror,* 14.01.2003.

44 U.S. Department of Energy: Non-proliferation and Arms Control Assessment of Weapons-Usable Fissile Material Storage and Excess Plutonium Disposition Alternatives, Washington 1997, pp. 37-39. National Academy of Sciences: Management and Disposition of Excess Weapons Plutonium, Washington 1994, pp. 32-33.

ments were stolen. In the meantime, the IAEA has secured and safeguarded all of the materials it was able to recover.

The disintegration of the Soviet Union also showed that 'failing states' could pose proliferation risks for the international community. There can be no guarantee that all of the countries who operate research reactors or civilian nuclear programmes will never become instable or collapse – losing temporary or permanent control over their nuclear facilities and nuclear material in the process. While it has been widely acknowledged that 'failing states' pose a general security problem, it is less well known that they may hide significant proliferation risks. The collapse of the nuclear power Pakistan, for example, would cause serious problems. Pakistan and the 'nuclear supermarket' of the Khan network including Malaysia also make it apparent that an increasing number of developing states can now deliver the technology required for nuclear programmes and nuclear weapons.

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5. Instruments to control and contain proliferation

5.1 Important treaties

The Non-Proliferation Treaty, which came into force in March 1970, is the foundation stone of the international non-proliferation system. Almost all of the countries in the world have signed the agreement. Only Israel, India, and Pakistan have never become members. North Korea withdrew from the Treaty in 2003.[45]

In Article 2, the NPT commits non-nuclear states, "not to receive the transfer from any transferor whatsoever of nuclear weapons or other nuclear explosive devices or of control over such weapons or explosive devices directly, or indirectly; not to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices; and not to seek or receive any assistance in the manufacture of nuclear weapons or other nuclear explosive devices".[46]

Vice versa, nuclear weapons states commit themselves in Article 1 not to help non-nuclear states to circumvent these commitments directly or indirectly. Article 4 guarantees the non-nuclear weapons states the right to use nuclear energy for peaceful purposes and to retain any relevant technology: "Nothing in this Treaty shall be interpreted as affecting the inalienable right of all the Parties to the Treaty, to develop, research, produce and use nuclear energy for peaceful purposes. (...) All the Parties to the Treaty undertake to facilitate, and have the right to participate in the fullest possible exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy."

Therefore, the treaty makes a distinction between states who continue to be authorised to possess nuclear weapons ('Haves') and states who are not ('Have Nots'). It also contains two provisions signalling that this distinction was and is not intended to exist forever. The first provision

45 Because North Korea made a faux pas in withdrawing from the NPT it continues to be treated as a non-nuclear member of the regime.

46 The text of the treaty, as well as many documents about international non-proliferation efforts, can be read accessed in: Federal Foreign Office: Preventing the Proliferation of Weapons of Mass Destruction, Key Documents, 2nd Edition, Berlin 2006.

is contained in Article 6 and commits the nuclear weapons states "to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control."

The second provision is contained in Article 10 and reads: "Twenty-five years after the entry into force of the Treaty, a conference shall be convened to decide whether the Treaty shall continue in force indefinitely (…)."

In 1995, this review conference for the treaty was held. It agreed to extend the treaty unconditionally and indefinitely. This decision was made possible because a "Principles and Objectives" document was agreed upon at the same time and further supplemented by a document containing 13 practical steps created during the next review conference in 2000. This document contained for the first time concrete aims and a working plan for strengthening both non-proliferation and disarmament by the nuclear weapons states.

These decisions showed the equally important factor of a 'trade off', which had also been apparent during the negotiations for the NPT: strict regulations for non-proliferation were for many non-nuclear states only acceptable when advances were also made with nuclear disarmament at the same time – with the ultimate goal of abolishing all nuclear weapons. Progress in the implementation of these obligations between 1995 and 2000 developed as a result at a considerably slower pace than most countries had expected. During the next review conference in May 2005, the situation deteriorated even further: the USA under the George W. Bush administration made it clear that they no longer felt committed to the "Principles and Objectives" and the agreed thirteen step process that was developed with the cooperation of the previous administration under Bill Clinton. The U.S. government now concentrates more on unilateral initiatives to strengthen non-proliferation and no longer accepts further obligations in terms of the disarmament of the nuclear weapons states. This has placed a fundamental question mark over the whole idea of a 'trade off', which had been established by the NPT and its extension agreements. The conference ended without any new agreements and left a difficult problem for the future. Is it possible to revive the multilateral non-proliferation regime and if so, how?

In addition, the treaty already has several weaknesses that are relevant for proliferation:

- the distinction between 'Haves' and 'Have Nots' is unique under international law, where all sovereign states are normally treated as equal. The open-ended extension of the NPT 'perpetuates' this difference in status, when the goal of nuclear disarmament to a level of 'zero' weapons has been lost sight of in the process. Therefore, many non-nuclear states have reacted with growing criticism as the U.S. government withdrew its support for the "Principles and Objectives" and the document containing the '13 step' process, viewing this as an unwillingness to disarm. This conflict has the potential to fundamentally undermine the NPT.
- the treaty guarantees all members the right to use nuclear technology for peaceful purposes. It commits nations in possession of such technologies to allow access to these technologies by nations who do not possess them, but who want to use them for civilian purposes, such as electricity production. According to the NPT, it is completely legal for a non-nuclear weapon state to operate a closed fuel cycle.[47] This includes a number of facilities that possess a high inherent proliferation risk. Proposals for additional safeguards and export restrictions for these elements of the fuel cycle – often made or supported by the nuclear 'Haves' states – increase the divide mentioned above. Non-nuclear weapons states fear a sort of 'nuclear apartheid' with regard to the civilian use of nuclear energy and access to advanced technology.

47 All nuclear facilities that for example Iran possesses and – as far as it is known – plans, are permissible according to the NPT for exclusively civilian use if monitoring by the IAEA is allowed.

Israel, India, and Pakistan never signed the treaty, but still acquired nuclear weapons. Since the treaty does not allow for new nuclear weapons states to become members, a decision to give up nuclear weapons would be a precondition for any of these states to join the treaty. This is unlikely to happen. Therefore, many non-nuclear weapons states are becoming increasingly critical about these nuclear weapons states being tolerated as de facto nuclear weapons states outside the treaty or being indirectly recognised. The most important piece of evidence cited for this trend is the bilateral agreement between the USA and India, which was negotiated under the George W. Bush administration and should enable cooperation between the two states on civilian nuclear projects,[48] as well as Washington's policies towards Israel.

The Comprehensive Test Ban Treaty (CTBT) is a further multilateral treaty potentially having an impact on proliferation. In February 1963, Robert McNamara wrote in a memorandum to President John F. Kennedy: "A comprehensive test ban agreed to by the USA, USSR and UK will work in the direction of slowing diffusion (of nuclear weapons). It is probably not an exaggeration to say that it is a necessary, but not sufficient requirement for keeping the number of nuclear countries small."[49]

However, it was not until after the Cold War that such a treaty could be agreed. Since 1996, 182 countries have signed the treaty and 151 have ratified it, this includes nuclear weapons states such as Russia.[50] However, it still remains unclear whether it will ever come into force. All 44 countries with a civilian or military nuclear programme must ratify the treaty before it comes into effect. Many of the countries – including the People's Republic of China, India*, Pakistan*, North Korea*, Indonesia, Israel, Iran and the USA have not yet ratified the treaty; three countries have not even signed it.[51]

If this treaty were to come into force it would make an important contribution to non-proliferation. Countries building nuclear weapons for the first time would not know for certain whether their nuclear weapon design functions as planned. This is particularly true of weapons based on reactor plutonium.

The goal of the proposed Fissile Material Cut-Off treaty is to freeze the amount of weapons-grade materials worldwide, ban the production of fissile materials for nuclear weapons and in this way enable the ultimate reduction of these materials. Although the idea has already existed for decades and resolution 1148 of the UN General Assembly called for an end to the production of weapons-grade nuclear materials as early as 1957, serious negotiations in the UN Disarmament Conference, which was charged with drafting the treaty, have still not begun. However, informal discussions about possible elements of such a treaty are now taking place there. The appointment of a working group on this topic was entered into the work plan for the Disarmament Conference last year. Nevertheless, it did not result in any significant progress. There are 65 countries taking part in the UN Disarmament Conference who must reach a consensus. Consequently, a willingness on the part of even the smallest nuclear powers, which are still building up their nuclear weapon stocks and have not yet joined the NPT, is a prerequisite for making substantial progress.

48 Since then, China and Pakistan have signed a similar agreement.

49 Secretary of Defense: Memorandum for the President, Subject: The Diffusion of Nuclear Weapons with and without a Test Ban Agreement, Washington DC 12.2.1963, p. 3 (original classification: SECRET).

50 For a general insight, cf. http://www.ctbto.org/ http://www.ctbto.org/the-treaty/status-of-signature-and-ratification/ for the status of countries who have signed or ratified the treaty.

51 States marked with a * have neither signed nor ratified the treaty. cf. http://www.ctbto.org/the-treaty/status-of-signature-and-ratification/?states=4&region=63&submit.x=17&submit.y=4&submit=submit&no_cache=1 (Status: Dec 2009). Under President George W. Bush, the U.S. government considered withdrawing their agreement to the CTBT which they had already signed. President Obama has announced he will seek ratification of the treaty, but he does not yet have the required majority in the U.S. Senate.

In the nuclear weapons states, this sort of agreement would limit the amounts of available fissile weapons-grade materials to the already existing stocks, and also serve as an additional security measure in the non-nuclear weapons states by making the accumulation of such stocks a violation of international law. In combination with the already existing undertakings, such as the agreement between Russia and the USA to blend down 500 tonnes of Russian weapons-grade uranium to low-enriched uranium and the agreement to each make 34 tonnes of plutonium unusable for military purposes, the reserves of available weapons-grade fissile materials would be reduced in the long term.[52]

Furthermore, there is a proposal for a "Fissile Material Treaty" which would also include existing potential weapons-grade nuclear materials and legally bind all nuclear powers to reduce their stocks of these materials.

In many regions of the world, Nuclear Weapon Free Zone Treaties have been established in accordance with Article 7 of the NPT. They constitute regional confidence-building measures against the possible proliferation of nuclear weapons and technology, which are supported on behalf of the nuclear powers by politically binding so-called 'negative security assurances'. These assurances promise in a political, although not legally binding, form that the nuclear weapons states will neither threaten nor attack the member states in the nuclear-free zones with their weapons.[53]

Other multinational agreements are concerned with the security of weapons-grade materials and specific interrelated issues. These include, for example:

- the international "Convention on the Physical Protection of Nuclear Materials"[54] from 1980, which came into force in 1987 and was initially only concerned with the security of the international transport of nuclear materials. This agreement has so far been signed by 142 states. In 2005, it was supplemented by an additional agreement containing obligations for the security of civilian nuclear facilities, nuclear materials and storage, as well as the transport aspect;[55]
- the "International Convention for the Suppression of Acts of Nuclear Terrorism" from 2005;[56]
- technical implementation agreements for the protection of nuclear materials and facilities on behalf of the International Atomic Energy Agency, which are currently in the final revision phase (INFCIRC 255/Rev.4 (1999) and Rev.5 (2010)).[57]

5.2 Non-proliferation through safeguards

International safeguards against proliferation are based on Article 3, paragraph 1 of the Non-Proliferation Treaty. The basic principle is that non-nuclear states will only be entitled to receive nuclear materials and corresponding technology if they allow the IAEA to verify that their nuclear programmes are for peaceful purposes only. Therefore, the main focus of the controls is to prevent nuclear materials from a civilian fuel cycle finding their way into military channels.

The monitoring system existing today was developed in two phases. During the first phase, a framework for the implementation of safeguard agreements was initially created and in the second, detailed guidelines were then negotiated for the conduct of IAEA inspections. Agreement on this document, Information Circular 153 (INFCIRC 153), was reached in 1972. Based on

52 www.bellona.no/en/international/russia/nuke_industry/co-operation/8364.html
http://www.nti.org/c_press/analysis_ Holgate_INMM%20Paper_061005.pdf

53 However, in the form (political but not legally binding) and content of these assurances the nuclear power states keep the option open to ultimately withdraw this guarantee.

54 cf. http://www.iaea.org/Publications/Documents/Infcircs/Others/inf274r1.shtml

55 cf. http://www.iaea.org/About/Policy/GC/GC49/Documents/gc49inf-6.pdf

56 cf. http://www.un.org/ga/search/view_doc.asp?symbol=A/Res/59/290

57 All information circulars (INFCIRC) from the IAEA can be seen at the following internet address:
http://www.iaea.org/Publications/Documents/Infcircs/index.html

these foundations, agreements on safeguards between the IAEA and individual states were concluded and published. The agreements regulate when and to what extent non-nuclear states are obligated to provide the IAEA with certain information about their nuclear facilities, materials and programmes. They entitle the IAEA to verify the correctness of the information received through inspections carried out inside the member state. In cases where the IAEA judges that a country has fully cooperated with the IAEA and only worked on civilian nuclear projects, this country can continue to receive nuclear materials, technology, etc. However, if the IAEA judges that there are doubts or open questions about a country's nuclear programme, it is entitled to begin additional special investigations with the purpose of either clearing the country of existing suspicions or reporting possible violations of these obligations to the UN Security Council and the UN General Assembly for a decision on further action. At the beginning of 2008, there were 163 agreements in force between the IAEA and individual countries.[58]

Following the Gulf War of 1991, IAEA inspectors revealed that the non-nuclear state of Iraq had been running a secret nuclear weapons programme for many years. The UN Security Council authorised the IAEA to carry out further inspections after the end of the war. Uncovering the Iraq nuclear programme led to the conclusion that the existing agreements about safeguards were not sufficient to prevent a country from establishing a secret nuclear weapons programme and that additional, more comprehensive controls were required to deal with such challenges. By 1997, the IAEA members had negotiated a voluntary "Model Additional Protocol" (INFCIRC 540) on extended safeguards. Those countries who accept this protocol enable the IAEA, amongst other things, to carry out additional, short-notice inspections or take environmental samples. In addition, the protocol commits members to inform the nuclear energy authorities earlier and in greater detail about newly planned nuclear facilities and to provide the IAEA with additional information so that, for example, declarations about all imports and exports of goods listed in the "Nuclear Suppliers Group Trigger List" are included. At the end of 2008, this additional protocol was in force for 88 countries.[59] Other states have signed the protocol but have not yet ratified it.[60]

The additional protocol is of specific value if a country is under suspicion of violating its commitments under the NPT or the safeguards. When the Islamic Republic of Iran came under such suspicion in 2003, the IAEA and many member states put Iran under pressure to sign the additional protocol so that Iran granted the IAEA the additional rights contained within. In November 2003, Iran signed the protocol. However, while the Iranian government initially behaved as though the protocol were in force, the Iranian parliament has since voted against its ratification. In February 2006, the Iranian government informed the IAEA of the parliament's decision that Iran would no longer recognise the protocol due to the escalating dispute about its nuclear programme, but has initially abided by some of the obligations that grew out of this protocol in practice.

The objective of the safeguards is to prevent the use of civilian nuclear capacities for military purposes in non-nuclear weapons states. They neither deal with military installations in nuclear weapons states nor with civilian nuclear installations in these countries, unless the nuclear weapons states specifically agree to place certain installations or materials under IAEA safeguards (INFCIRC 66).[61] Safeguard agreements can also be concluded for nuclear facilities in states who are not members of the NPT. This has seen Israel, India and Pakistan

58 cf. http://www.iaea.org/Publications/Reports/Anrep2008/safeguards.pdf

59 Ibid.; a more current individual overview about which safeguard agreement with which country had which status in December 2009 is offered by the IAEA here: http://www.iaea.org/OurWork/SV/Safeguards/sir_table.pdf

60 About the situation in December 2009 cf. http://www.iaea.org/OurWork/SV/Safeguards/sir_table.pdf

61 The nuclear weapons states make use of this opportunity to varying extents. For example, U.S. President Barack Obama issued Congress on the 6th May 2009 with a 267 page list of all nuclear facilities that Washington had reported to the IAEA.

now allowing the IAEA to carry out limited monitoring of safeguards on their territory.[62]

Although IAEA inspections have been repeatedly criticised for being costly, time-consuming and insufficient, they are clearly much more effective than their critics claim. In Iraq, the IAEA inspectors (and the United Nations Monitoring, Verification and Inspection, UNMOVIC) discovered the Iraq nuclear programme. During the dispute in 2003 in which the USA and Great Britain sought the required support of the United Nations for a renewed war against Iraq, they came to the correct conclusion that this programme had not been resumed.

Current suggestions to strengthen IAEA safeguards include calls to make the additional protocol universal and mandatory for non-nuclear states seeking to import nuclear-related goods. In addition, the idea of introducing a new generation of safeguards is once again being considered.

5.3 Non-proliferation by export controls

Multilateral export control measures have supplemented the IAEA safeguards since the early 1970s. They are based on Article 3, paragraph 2 of the NPT, which commits all member states to only supply nuclear materials or technologies if they are subject to the IAEA safeguards in the recipient country.

Those states capable of supplying nuclear technology began to hold informal meetings in 1971. Later, these discussions were institutionalised and became known as the Zangger Committee. The members of the committee developed a list of nuclear export goods ('trigger list'), which required the introduction of controls and established three conditions for countries who wanted to receive such goods: the recipient must have a safeguard agreement in place, use all his imports for peaceful purposes, and apply these two conditions to potential recipients of re-exports.

Those countries who were in a position to supply nuclear materials or technology also established the informal Nuclear Suppliers Group in 1975. The group also agreed on an extensive 'trigger list' of nuclear materials, technologies, and equipment that should be subject to national export controls, as well as on a list of important technologies that could be used for both military and civilian purposes ('dual use'). These lists are updated from time to time in order to keep pace with developments in technology.

Both lists are part of the Nuclear Suppliers Group guidelines, which are politically but not legally binding. However, if member states are committed to including the goods in their national export-control system, the guidelines do then become legally binding.

In recent years some new initiatives have been launched to strengthen control over the supply of nuclear technology. Based on a proposal from the USA, the G8 Summit in June 2004 agreed on an extendable one-year moratorium on new transfers of uranium enrichment and reprocessing technologies to states not already in possession of such technologies. This moratorium continues to be followed by the eight countries up until today,[63] because it has not yet been possible for the Nuclear Suppliers Group to agree on a common policy. In 2009, the IAEA Board of Governors voted with a majority of 23 to 8 votes for a Russian proposal in which Russia should hold a reserve of 120 tonnes of lightly enriched uranium for international use by states with electricity producing reactors. Egypt, Argentina, Brazil, Malaysia and South Africa amongst others voted against this proposal. This increased the scepticism, with which many non-nuclear weapons states continue to regard the safeguards, export controls and visits, about nuclear relevant exports being dependent on whether the recipient country fulfils additional requirements. They fear that these regulations are being used in a discriminatory manner and they could impede or prohibit legiti-

62 cf. http://www.iaea.org/OurWork/SV/Safeguards/sir_table.pdf

63 This happened in a slightly unnoticed manner through repeated affirmations of paragraph 8 of the G8 communiqué from L'Aquila.

mate access to modern nuclear technology, as guaranteed by the NPT.

If this problem is to be resolved then proposals must be put into effect for the components of the fuel cycle relevant to proliferation to be 'multilateralised'. For example, uranium enrichment or reprocessing to be carried out for multinational use only and furthermore in facilities controlled by the IAEA. This would have the effect of increasing resistance to proliferation.

5.4 Non-proliferation by cooperation

The break-up of the Soviet Union and the concern about the huge nuclear legacy led to a wide range of cooperative non-proliferation measures with the successor states. The United States was the quickest to take the initiative and is now involved in the financing and implementation of such activities in a whole range of countries.[64] In addition, many of the programmes developed in this context have now proved useful in other countries.

Various projects aim at a more centralised and technically secure storage of nuclear materials and weapons in Russia and the other successor states of the Soviet Union. Others aim at securing the nuclear fuel from decommissioned nuclear-powered submarines. Projects such as the International Science and Technology Center Programme, the Nuclear Cities Initiative, the Russian Transition Initiative, and the Proliferation Prevention Initiative focus on creating employment for nuclear scientists in order to avoid a so-called brain drain, – preventing proliferation that could result from scientists seeking employment abroad. Other programmes focus on the improvement of border and export controls in Soviet successor states, while some attempt to cooperatively end weapons-grade fissile material production in Russia and reduce fissile material stockpiles in the country.

Under the Trilateral Initiative in 1996 for example, the United States, Russia and the IAEA agreed to place weapons-grade fissile material that had been deemed surplus to requirements (both plutonium and uranium) under IAEA control. In 1993, the United Sates purchased 500 tonnes of highly enriched uranium from Russia, which was downblended and used as fuel in U.S. nuclear power stations. According to data from the companies employed in the process, 382 tonnes of highly enriched uranium, the equivalent of 15,294 nuclear warheads, had been converted into low enriched uranium within the framework of the "Megatons to Megawatts" programme.[65]

The Plutonium Disposition Agreement from 2000, in which the USA and Russia initially agreed to each convert 34 tonnes of weapons-grade plutonium either into mixed oxide fuel or to immobilise it by mixing it with nuclear waste to make it storable and non-harmful, has been significantly less successful to date because its implementation has been consistently delayed.[66] The agreement was amended with an additional protocol in April 2010. Henceforth, Russia is allowed to completely convert its weapons-grade plutonium into MOX fuel and use it to power reactors and fast breeder reactors, which are subject to special non-proliferation controls.[67]

Since 2002, there has been the "Global Partnership Against the Spread of Weapons and Materials of Mass Destruction" from the G8. The G8 member states committed themselves to spend 20 billion dollars over a ten-year period on this initiative.

64 An overview can be gained on the following internet pages: http://www.ransac.org/ http://www.bits.de/NRANEU/NonProliferation/index.htm

65 http://www.usec.com/megatonstomegawatts.htm

66 The agreement was based on unilateral declarations from the governments of Clinton (1995) and Yeltsin (1997) to each declare 50 tonnes of weapons-grade plutonium as superfluous to military requirements. A bilateral commission developed options in 1996/97 for dealing with surplus weapons-grade plutonium that was used as a basis for the framework agreement in 1998 and the aforementioned agreement in 2000 between both states; see: http://www.nti.org/db/nisprofs/russia/fissmat/plutdisp/puoverww.htm. The USA plans to make use of both options, Russia views the weapons-grade uranium as a recyclable material and wants to process the complete stock into MOX. Neither Russia nor the USA possessed facilities for MOX processing at the time the agreement was concluded.

67 For the contents of the amendment cf. http://www.state.gov/r/pa/prs/ps/2010/04/140097.htm

In May 2004, the "Global Threat Reduction Initiative" was launched jointly by Russia, the United States and the IAEA. This initiative aims, amongst other things, to better secure fissile materials originating from the USA and Russia found in more than forty countries around the world and to repatriate it to its country of origin. The initiative is primarily interested in highly enriched uranium currently used in research reactors that was mostly originally supplied by either the Soviet Union or the USA. HEU is to be banished as a reactor fuel in civilian nuclear programmes. Research reactors powered by HEU are to be shut down or converted to using less-enriched uranium as a fuel source. The initiative had been joined by 90 states by 2007. Even before this initiative came into being, weapons-grade fissile materials from Serbia, Bulgaria and Kazakhstan had been transferred to the United States or Russia. During the Nuclear Security Summit in April 2010, a host of other states expressed their willingness to no longer use HEU in these sorts of reactors in future.

Many of the bilateral initiatives established by the USA and Russia have now become multilateral. These include help and support for countries to carry out the proliferation-reducing export controls effectively, as well as projects to create alternative employment for nuclear specialists and scientists, and to help secure nuclear facilities and materials. Discussions about safety and security deficiencies in the former Soviet Union have also contributed toward initiatives within the IAEA aimed at increasing the security of civilian nuclear operations.

5.5 Coercive non-proliferation and military counter-proliferation

During the George W. Bush administration, the USA focused more strongly on unilateral coercive measures to prevent proliferation. Two examples: in May 2003, the USA launched the Proliferation Security Initiative. Its aim was both to legitimise and make the interception of nuclear, biological or chemical weapons transport by air or sea easier. It also set its sights on missile systems and technology, processing technology and materials for all of these weapons. The idea was met with scepticism from many countries because its implementation would have placed it in violation with a host of international treaties, which guarantee the unrestricted passage of aircraft and ships. However, after the Bush administration had modified and limited the initiative to accommodate these legal concerns, other nations began to show more interest. Over 90 countries are participating in the initiative today.[68]

Counter proliferation operations are the second form of measures that should be mentioned. The purpose is to reverse or delay proliferation through the use of military force. This approach includes the possibility of using, for example, sabotage operations using special forces, military air or sea strikes and even interventions or strikes using nuclear weapons. There are also wide ranging and to some extent serious problems with international law in connection with these operations.

For example, should a state be prevented from building a nuclear weapon then such military operations would be in violation of international law as long as there was no UN mandate for this action. If a non-state actor attempting to build a nuclear warhead is tackled then the problems with international law become even greater. The military action would affect the territory of the state in which the non-state actor is located, completely independent of whether this state approves or is incapable of preventing the activities of the non-state actor. These types of missions can be carried out as preventative or pre-emptive actions, as well as retaliatory measures. In most cases, they imply a severe violation of international law, since from a legal point of view they are acts of aggression.

In addition, such actions to fight against proliferation are in many cases probably organised in secret to increase the element of surprise and the chances of success. Therefore, no attempt will have been made in advance to receive legitimacy for the action under international law. Indeed, it is possible that the operation is even carried out in secret or not even made public subsequently.

68 cf. http://www.state.gov/t/isn/c10390.htm

This also prevents action being taken under the legitimacy of international law. Under George W. Bush, the United States made this type of action an integral part of their published National Security Strategy. States such as Russia or France show a certain level of willingness to also consider the use of these types of operation. Even under President Obama, these operations have not been ruled out as a matter of principle. However, it has been emphasised that they should be carried out whenever possible using conventional methods. In contrast, George W. Bush kept open the option of even using nuclear weapons in such cases.

Most of these operations known to have occurred so far have taken place as part of existing wartime operations, such as Allied attacks and sabotage operations during World War II against the German controlled heavy water production plant, Norsk-Hydro, in Norway or the Japanese nuclear laboratory in Tokyo. Outside of wartime operations, other known occurrences included the Israeli attack on the Iraqi nuclear reactor in Osirak in 1981 and the Israeli air strike in 2007 on a suspected nuclear reactor in Syria.

In the case of the Iraq War in 2003, a whole war was justified to a large extent by the need to fight against the proliferation of weapons of mass destruction. However, in hindsight it turned out that much of the supposed 'evidence' with which the U.S. government justified its open engagement was untenable or even misleading. This highlights a further problem: the supposed requirement for secrecy and the alleged need to act swiftly because of imminent risk does not allow in many cases for the timely verification or rebuttal of the reasons that are used as a justification for military intervention in the field. This is not only true in the public arena but also for the responsible legislative authority whose role it is to control their executive government intent on war. Even international organisations like the United Nations generally have no opportunity to carry out such checks in a timely manner. Alleged or believed proliferation therefore can be used as a justification for war instead of verifiably detected proliferation and in extreme cases even as a contrived pretext for wars,[69] which are to be carried out for completely different reasons. When the findings of intelligence services play an important role, their source is often not revealed. In these situations, a timely verification or rebuttal of the accusations before the use of military force is virtually impossible. It may follow on at a later point in time but by then it is too late. What has come to pass cannot be undone.

Assessing the effectiveness of military intervention in eliminating or delaying nuclear programmes is extremely difficult. As far as it is known, their effect in the past has been rather limited or even counterproductive. It appears apparent that Iraq decided after the Israeli attack on its reactor to develop nuclear weapons. The many years of public debate about possible military intervention by the USA or Israel against Iranian nuclear facilities sheds new light on the complexity, the uncertainty of success and the uncertain nature of a military operation to destroy Iranian nuclear facilities.[70] In addition, it remains to be seen what type and extent of influence a military attack would have on future decisions in Iran for the direction of their nuclear programme. It cannot be ruled out that those forces in Tehran who advocate a military nuclear programme would be strengthened by such action.[71]

69 The 'Iraqi example' in 2003 can only serve as a lesson that there can be no similar 'Iranian example' with similarly meagre 'evidence'.

70 Experts question whether Israel has the military means to destroy the most important Iranian nuclear facilities without foreign assistance. The U.S. forces are believed by most to be capable of this but there are military experts who also doubt the ability of the USA to completely eliminate these facilities without warning or they advise against it because Tehran has too many options for retribution.

71 In the argument so far about nuclear weapons the government and opposition parties in Tehran have made every effort in their various roles to avoid giving any impression that Iran has reacted or yielded to outside pressure. Should this approach continue it cannot be excluded that the fears that Tehran wants to build nuclear weapons will become a self-fulfilling prophecy, although the future military direction of the Iranian programme at the beginning of the dispute was yet undecided or not planned.

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6. A contradictory approach – non-proliferation policy under Barack Obama

The presidency of Barack Obama in the USA marks a new turning point in nuclear non-proliferation and disarmament policies. After just three months in office, Obama held a speech on April 5, 2009 in Prague in which he not only declared he was striving for a nuclear free world but also committed himself to taking the necessary steps on behalf of the USA. Obama announced that he would:

- "reduce the role of nuclear weapons in our national security strategy and urge others to do the same";
- "negotiate a new Strategic Arms Reduction Treaty with Russia" that would set out the limitation and reduction of strategic nuclear weapons in both countries;
- "immediately and aggressively pursue U.S. ratification of the Comprehensive Test Ban Treaty";
- "seek a new treaty that verifiably ends the production of fissile materials intended for use in state nuclear weapons";
- strengthen "the nuclear Non-Proliferation Treaty as a basis for cooperation"; there needs to be more "resources and authority" to strengthen international inspections, "immediate consequences for countries caught breaking the rules", and there is a need for a "new framework for civil nuclear cooperation" including an international fuel bank for nuclear power plants, which countries can access without increasing the risks of proliferation.[72]

At the same time, Obama explicitly emphasised that every non-nuclear state had the right to unrestricted civilian use of nuclear technology as long as they kept to their obligations within the the Non-Proliferation Treaty and in dealings with the IAEA. This would, according to Obama, make a contribution to holding back climate change.

The announcements by Obama were quite clearly aimed at signalling the willingness of the USA to take part in multilateral non-proliferation policies. The timing and the content of his speech were important factors in the context of the forthcoming NPT review conference in May 2010. This conference should not be allowed to collapse as happened five years earlier. All of the important topics dealt with in the NPT were addressed and the fundamental principles of the 'deal' reaffirmed: the

72 http://www.whitehouse.gov/the-press-office/remarks-president-barack-obama-prague-delivered

nuclear powers should disarm; non-nuclear states should accept stricter non-proliferation controls and the right of all members abiding by the treaty to pursue the civilian use of nuclear technology was once again confirmed. According to Obama, the USA would be ready to take on a leading role on this path.

One year later in April 2010, Obama endeavoured to demonstrate the first practical developments and show that his actions matched his words. Within a period of seven days, he signed the Nuclear Posture Review – a blueprint for the future nuclear policy of the USA in the military arena – and returned to Prague to sign a "New START Treaty" alongside his Russian colleague Dmitri Medvedev. Lastly, he organised a summit conference for nuclear security in Washington with 47 different participating countries. All three projects had the goal of strengthening the implementation of the NPT. Yet can they actually deliver on this goal?

6.1 The New START Treaty

The New START Treaty, signed on the 8th April 2010,[73] limits the number of strategic nuclear missile systems of both parties to 800 each, of which 700 are allowed to be active, and the number of deployed strategic warheads to 1,550 each.

Washington and Moscow also emphasised that the number of missile systems therefore had been reduced by more than half in comparison to the START treaty that expired in December 2009. The number of warheads was 74 % lower and in comparison to the newer Moscow Treaty – the SORT Treaty from 2002 – the figure was 30 % lower. However, what at first glance appears to be a major new commitment to disarmament is in fact a rather small step.

Neither Russia nor the USA still possess a nuclear potential today that is anywhere near as great as that allowed at the time of the old START Treaty. If a comparison is drawn with the current active potential of both sides then it becomes clear that: the USA must only scrap a few dozen strategic missiles and place a further 100 missiles out of service. Russia does not have to do anything. As Russia only has 566 active missiles available, it could in theory even add an additional 200 systems to its arsenal – if it could afford them.

A similar picture emerges when looking at the number of warheads. According to estimates from the Federation of American Scientists and the Natural Resources Defense Council, the USA had around 2,200 warheads deployed on active missile systems in 2009 and held around a further 150 in reserve.[74] Russia possessed around 2,500 to 2,600 active warheads.[75] Therefore, at first glance the treaty seems to make somewhat more significant reductions: the U.S. government was required – if based on the absolute maximum figure from the Moscow SORT Treaty of 2,200 warheads in the year 2012 – to scrap 650 active warheads and the Russian government at least 950 warheads.[76] Yet appearances are deceiving. This seemingly significant disarmament step is for the most part the result of a clever trick with the figures and must not actually take place in reality. One detail of the New START Treaty makes this clear: strategic bombers will be generally counted in future as a single nuclear weapon; under the old START Treaty in contrast they counted as ten weapons if they were able to carry cruise missiles and only regarded as one weapon if they were only able to carry nuclear bombs. There was no revision of the agreements on this question in the Moscow SORT Treaty. In fact, these bombers can actually carry 6, 12, 16 or even 20 weapons each. This has two consequences:

73 The treaty can be seen here: http://www.state.gov/documents/organization/140035.pdf And the accompanying protocol here at: http://www.state.gov/documents/organization/140047.pdf

74 Hans M. Kristensen und Robert S. Norris: U.S. Nuclear Forces 2009, in: Bulletin of Atomic Scientists, March/April 2009, pp.59-60.

75 Hans M. Kristensen und Robert S. Norris: Russian Nuclear Forces 2010, in: Bulletin of Atomic Scientists, January 2010, p.76-77.

76 The SORT Treaty obligated both states to disarm to a level of 1,700-2,200 warheads each by 2012. If the lower limit is taken as the basis then the USA has a nominal disarmament obligation of 150 warheads and Russia a requirement to scrap 500 warheads.

firstly, only a few hundred weapons have to be disarmed on paper and secondly, both parties are allowed to retain a few hundred more weapons than the officially agreed 1,550 warheads.[77]

In addition, there is the fact that the New START Treaty like its predecessor does not impose any restrictions on how many warheads both parties are allowed to hold in reserve. This includes weapons that could be reactivated in a crisis situation and those that had not been delaborated. Even in the past, this was significantly more weapons then allowed according to the treaty. In 2010, both sides still possess considerably more than 20,000 non-delaborated nuclear weapons between them.

The limited disarmament obligations in the New START Treaty were played out in the USA against a background of domestic policy restraints. These resulted in binding restrictions placed on the President by the U.S. Congress in the Finance Bill 2010 for his negotiations on the New START Treaty. The Obama administration was not allowed, for example, to enter into any contractual agreements to limit the development of the missile defense system in the USA or the development and deployment of conventionally armed long-range weapons. Because Washington had focused on the building of land and sea-based conventional long-range weapons, this limitation forced Obama's negotiators into adopting a very conservative approach when discussing strategic missile systems. In addition, the New START Treaty requires the votes of at least 8 Republicans in the U.S. Senate to become ratified, many of whom fundamentally reject arms control agreements. Whether it will gain the required two-thirds majority in the U.S. Senate for ratification due to the negligible encroachments of the treaty into the current nuclear weapons potential of the USA remains to be seen.

The limited scope of the newly agreed disarmament obligations is unlikely to be sufficient for the vast majority of member states within the NPT and therefore hardly convincing enough for them to agree to significantly improved non-proliferation regulations during the review conference.

6.2 The Nuclear Security Summit

Barack Obama invited selected representatives from the international community to a Nuclear Security Summit in Washington on April 12 and 13, 2010. The invitation went out to a total of 47 states. The goal of the summit was to initiate a process in which the countries taking part made a commitment to stricter security measures for restricting or renouncing the use of weapons-grade fissile materials on their territories. The summit agreed a communiqué[78] and a working plan.[79] Both documents were non-binding but rather political expressions of good will on a voluntary basis. The agreements focussed on the voluntary commitments of the member states:

- to strengthen international agreements, such as the conventions for the physical protection of nuclear materials and the prevention of acts of nuclear terrorism, through their quick and successful implementation as well as through an increased promotion of their universalisation; the same is also true of the UN Security Council resolution 1540,[80] whose goal it is, amongst other things, to keep weapons of mass destruction out of the hands of non-state actors;
- to implement and strengthen a number of initiatives from the IAEA that serve the improved security of nuclear materials and facilities, such as the updated INFCIRC 225, the Nuclear Security Plan 2010-2013 and the planned new technical guidelines for Nuclear Material Accountancy Systems at Facilities;[81]

77 How many weapons this would amount to in the final reckoning is dependent on how many strategic bombers both sides declare in future as strategic missile systems. Russia and the USA both intend to modernise their stock of nuclear air-based cruise missiles.

78 cf. http://www.whitehouse.gov/the-press-office/communiqu-washington-nuclear-security-summit

79 cf. http://www.whitehouse.gov/the-press-office/work-plan-washington-nuclear-security-summit

80 cf. http://daccess-dds-ny.un.org/doc/UNDOC/GEN/N04/328/43/PDF/N0432843.pdf?OpenElement

81 The continued operation of the research reactor in Garching with HEU is guaranteed with this wording because the development of alternative uranium-molybdenum fuel has not yet reached the stage where the conversion of the reactor is technically feasible.

- to secure nuclear materials, particularly those used for weapons, and nuclear facilities in a suitable manner and to keep access to the information and technology required to use nuclear materials for dangerous purposes out of the hands of non-state actors;
- to promote measures with which highly enriched uranium and separated plutonium (weapons-grade and reactor plutonium) can be secured and documented, to consolidate the storage of these materials and to promote the conversion of highly enriched uranium reactors to low-enriched uranium, "where this is technically and economically possible", as well as replacing HEU targets with other materials where this is possible;
- to strive for the prevention of nuclear smuggling and for an improved exchange of information, as well as to achieve increased expertise in the area of nuclear forensics;
- to improve measures for the secure utilisation of radiological resources and to consider what further steps can be taken in this regard.

The Nuclear Security Summit was able to initiate the desired process of continuous cooperation. A further summit will now take place in two years in Seoul. Barack Obama was able to signal his willingness for broadly based multilateral non-proliferation initiatives and make it clear in the process that he was not – in contrast to his predecessor George W. Bush – intent on following a unilateral approach. Ultimately, the summit can be evaluated as having sent a signal to all members of the NPT that the security of nuclear materials and facilities is being afforded an increasing level of attention by a large group of countries. However, no substantial new initiatives resulted from the summit.

Nevertheless, the summit was associated with a very ambivalent signal: the Obama government placed – as in its Nuclear Posture Review (see 6.3) – the prevention of terrorist attempts to gain access to nuclear materials, technology or even weapons clearly at the forefront of its arguments. By emphasising this threat in the risk analysis and in the arguments used to promote a process of voluntary commitments, it was comparatively easy to win the support of a relatively large number of states or to make it more difficult for them to maintain opposition. But this approach also has a flipside: the risk that terrorists will try to gain access to weapons-grade nuclear materials is lower than the risk that other states will try to do this. If the voluntary commitments were also consequently applied to all state actors, who are after all affected by many of the measures endorsed or agreed, then it is to be expected that some state actors will view these demands as discriminatory.

6.3 The Nuclear Posture Review

The Nuclear Posture Review,[82] presented on the April 6, is a report requested by the U.S. Congress in which President Obama defined all of the important aspects of his future nuclear policies. It covers the areas of nuclear politics, nuclear strategy and doctrine, nuclear weapons potential and its future, as well as conceptual statements about the future of military nuclear industrial complexes.[83] The future of the civilian use of nuclear energy is not part of this report. Only those aspects of the report are handled here that are of particular importance to the future of the non-proliferation regime.

The document contains for the first time the explicit goal of a world free of nuclear weapons. It describes the danger of terrorists gaining access to materials for building a nuclear weapon, or possibly even using a nuclear weapon, as the greatest threat of our time, followed by the proliferation of nuclear weapons to other states and it declares, therefore, that the revival and strengthening of the NPT regime is one of the priorities of Obama's nuclear policies. This is also the first time that this has appeared in a document for strategic nuclear policy in the USA. The maintenance of a deterrent and of strategic stability against other nuclear

82 http://www.defense.gov/npr/docs/2010 Nuclear Posture Review Report.pdf

83 A comprehensive collection of documentation and studies on this topic can be found here: http://www.bits.de/main/npr2001.htm

powers like Russia and China ranks only third in order of priority. The review highlights the fact that the new administration wants to regard the use of nuclear weapons with significantly greater restraint than all of the country's previous administrations. In particular, it sets itself clearly apart from the politics of George W. Bush. According to the Nuclear Posture Review, the USA can also confront many of those risks for which the Bush administration kept open the use of nuclear weapons – such as the use of chemical and biological weapons by non-nuclear states – by using conventional measures. The "fundamental task and role" of nuclear weapons is to "deter a nuclear attack on the USA, its allies and partners". The review presents the goal of further reducing the role of nuclear weapons so that the deterrent of a nuclear attack will become the "only role" of nuclear weapons in future. However, the option of using nuclear weapons must be kept open until this is achieved "to protect under extreme circumstances the vital interests of the USA, its allies and partners".

The report also provides a new and clearer summary of the important negative security guarantees for non-nuclear states that are relevant under the NPT regime: the "United States will not threaten states with the use of nuclear weapons or use nuclear weapons against states who are non-nuclear members of the Non-Proliferation Treaty and who fulfil their obligations in terms of nuclear non-proliferation."[84] This guarantee is also explicitly given for a situation where one of these states uses biological or chemical weapons.[85] Therefore, only those nuclear powers and states that do not fulfil their obligations under the NPT are faced with the threat of nuclear weapons from the U.S.. At the present time, this means primarily North Korea and Iran. The U.S. government also retains the right to use nuclear weapons in response to such states using biological and chemical weapons – a clear indication that Washington continues to keep the right to the first use of nuclear weapons. This right is no longer explicitly mentioned in the new Nuclear Posture Review.

However, two very problematic aspects remain unresolved: who decides whether a state has fulfilled its obligations to the NPT or not? The United Nations, the IAEA or the U.S. President?[86] In addition, it is also unclear whether this decision will be taken based on clear proof or on assumptions believed to be true. Both of these aspects were highlighted in a disreputable and disturbing way in the war against Iraq in 2003.

In the area of declaratory policies, the role of nuclear weapons under Barack Obama has been significantly limited and reduced. Nevertheless, it is likely to take a number of years until these changes are reflected in the strategic planning, operational planning and contingency planning of the U.S. armed forces. Until that is the case, planning will continue to follow the rules laid out during the George W. Bush administration.[87] It also remains to be seen to what extent and how quickly the armed forces will implement Obama's 'political' guidelines. They may retain the hope that a future Republican president will change the declaratory policy of the USA once again.

In terms of the future of American nuclear forces, the Nuclear Posture Review envisages

84 By way of comparison: under George W. Bush this was formulated in 2002 as: "The United States will not use nuclear weapons against non-nuclear weapons states parties to the Treaty on the Non-proliferation of Nuclear Weapons, except in the case of an invasion or any other attack on the United States, its territories, its armed forces or other troops, its allies or on a state toward which it has a security commitment, carried out or sustained by such a non-nuclear weapon state in association or alliance with a nuclear weapon state." This highlights that the role of nuclear weapons under George W. Bush had a much broader scope.

85 In the event that there is a technical breakthrough in terms of the use and effectiveness of biological agents, the Obama administration reserves the right in the Nuclear Posture Review to a return to the previous policy.

86 In Washington, the answer to this question is so self-explanatory that it does not even need to be posed in the first place. The President decides and can gain international support for this position but is not required to do so.

87 This is shown e.g. in the OPLAN 8010-08 "Strategic Deterrence and Global Strike" in the version from February 2009; cf. Hans M. Kristensen: Obama and the Nuclear War Plan, Federation of the American Scientists Issue Brief, February 2010.

only minimal changes. It remains unequivocally conservative in retaining existing structures. Naturally, the New START Treaty should be implemented. Preliminary investigations into further discussions with Russia should also be carried out. However, the USA will retain its triad of nuclear missile systems and only make limited changes. The already initiated reduction to the number of warheads on intercontinental ballistic missiles (from 3 to 1) is to be completed; in two years the decision will be made about whether to relinquish two strategic submarines. It was also possible to reduce once again the number of long-range bombers with nuclear capability. Yet these changes are not really significant.

In contrast, a clear signal can be taken from the decision to continue with all important modernisation projects in the area of nuclear missile systems and to develop and introduce their replacement systems. Approval has been given, for example, to the development of a new long-range cruise missile, a new bomber and a new generation of submarines for strategic missiles, which will be built from 2019 onwards and are to guarantee an "uninterrupted strategic deterrence right up to the 2080s".[88]

Similarly, the Nuclear Posture Review also approves continued modernisation of the nuclear warheads for the trident missiles (W76-1), a comprehensive modernisation programme for the B61 family of bombs (B61-12)[89] and preparations for the modernisation of the warheads used for intercontinental missiles (W78). In order to be able to implement these projects, substantial investment has been approved for military nuclear industry complexes to enable the modernisation or the new construction of many facilities.

The 'New Triad' concept introduced by George W. Bush and a deterrence that in future will consist in future of a nuclear component, missile defense system and conventional long-range weapons for 'prompt global strikes' has been maintained by the new administration. It is also planned to transfer this strategy to regional deterrence systems, for Europe and NATO, the Middle East, as well as the Far East (South Korea, Japan).

These decisions about the future of military nuclear hardware are in clear contrast to the changes in declaratory policies. They give the impression that the vision of a nuclear weapon free world is at best a vision for the 22nd century. Therefore, they have a counterproductive effect in terms of the requirements for a promising, improved nuclear non-proliferation policy.

6.4 Words and actions – problems and contradictions

In comparison to the announcements in his speech in Prague, the verdict on Obama's actual policies is mixed. The President has endeavoured to agree a new disarmament treaty with Russia and realised this goal – but has not yet managed to push the agreement through the U.S. Senate. The Obama administration has not been able to achieve the promised ratification of the Test Ban Treaty because it feared it would fail to pass through the U.S. Senate; a danger that also exists to a significantly lesser extent with the New START Treaty. The promise to reduce the role of nuclear weapons in the administration's security strategy has been honoured even when it did not go far enough for many people. His efforts to revive multilateralism and to strengthen the NPT regime to enable the implementation of stricter non-proliferation regulations are clear. The decision for the conservative restructuring of the country's nuclear weapons potential and to support practically all of the existing modernisation planning introduced under George W. Bush in this area may well have been necessary due to domestic political concessions but will however prove a great hurdle to significantly improving non-proliferation policies.

88 cf. http://www.senate.gov/~armed_services/statemnt/2010/03%20March/Johnson%2003-17-10.pdf
89 Two tactical versions, the B61-3 and the B61-4, are deployed in Europe.

In addition, Obama's nuclear policies are extremely contradictory on two particular points. Both represent considerable risks: firstly, the Obama administration regards nuclear terrorism and the danger of proliferation to non-state actors as the greatest threat in the future.[90] Therefore, it aims to make non-proliferation policies and the strengthening of the NPT regime its priorities. This requires strong signals of the United States' willingness for nuclear disarmament, which when the consequences are drawn from Obama's risk analysis, should lead to much deeper cuts in the country's existing nuclear potential than have been so far planned. In contrast, the decisions about the future of the U.S. nuclear potential signal something completely different: the scope and configuration of the nuclear forces are primarily and unambiguously oriented towards remaining on at least an equal footing with other nuclear powers, or holding a superior position in the long run. In addition, they signal that the United States aims to retain a strong, modern nuclear force far into the second half of this century and to possess the ability and the infrastructure to also modernise this force further. There is a high probability that this will be a major hurdle in combating the dangers of proliferation because it undermines the willingness of many other states to accept stricter non-proliferation regulations for the purpose of strengthening the NPT regime.

The second contradiction in Barack Obama's nuclear policies shows that he is a prisoner of the inherent inconsistencies of the NPT: Obama emphasises again and again the right of non-nuclear states to comprehensively utilise nuclear energy for civilian purposes. In support of this view, he points out that nuclear power plants could play an important role in the reduction of CO_2 emissions and in holding back climate change. Obama has indicated that the United States will build new nuclear power plants itself and is promoting this ideal through the provision of favourable loans to the value of 54 billion dollars. Finally, his administration has indicated that they will provide major support to efforts for building and developing a new generation of nuclear power plants, which are as proliferation resistant as possible, for the purpose of export. This may all be understood as a well intended signal for non-nuclear states that want to and – according to Obama – should use civilian nuclear energy. In practice, this approach can only be followed by those who are prepared to accept significantly greater proliferation risks than those that currently exist.

90 It is doubtful, however, whether terrorism actually represents the greatest nuclear threat. It is possibly only the most opportunistic. "The creation of further nuclear weapons states and 'multidirectional deterrent systems', which may fail much more easily, are seen by many experts as the greatest risk".

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7. A world in search of energy

Concerns are growing about whether today's most important sources of primary energy – oil and natural gas – will continue to meet the growing demands of the world's population. Despite the financial crisis, the worldwide demand for energy continues to grow rapidly. Since Asia has taken over much of the labour and energy intensive production processes, which were previously located in the now de-industrialising Western world, the demand for energy in this region has risen dramatically. A sufficient supply of energy and electricity has become one of the basic requirements for development. However, the earth's reserves of both oil and gas are limited and they can only be supplied at an affordable price in limited quantities at any one time and to any one place. Sooner or later bottlenecks are to be expected due to the differences between supply and demand, the depletion of reserves recoverable at economic prices or resulting from regional conflicts. In parallel, awareness is growing that fossil fuels contribute to a large extent to climatic change and their increased use is not compatible with limiting the risks resulting from this climate change. Thus searching for alternative and additional sources of energy has become a major trend – in both the Western world and in developing nations. Nuclear energy – alongside the undeniably important renewable energies – is one of the alternatives being looked at with increasing intensity.

Various studies assume that it is possible to limit proliferation while at the same time continuing to export civilian nuclear technology.[91] The policies of the new U.S. government also appear to be motivated by this point of view. However, the political proposals for non-proliferation that have been offered for this purpose are likely to be about as promising and effective as those that were proclaimed in the 1960s and 1970s. They make it possible to buy a little time until gaps and loopholes once again manifest themselves through the first cases of proliferation. When non-state actors begin to become actively engaged in this field then most parts of the non-proliferation regime – created to prevent proliferation between states – will only have a limited effect or even more loopholes will be seen appearing than before. What is overlooked by those who advocate

91 cf. e.g.: The Atlantic Council: Proliferation and the Future of Nuclear Power, Washington DC 2004.

the export of nuclear technology despite proliferation and security issues, is that they are largely denying the existence of a central problem: it is not possible on the one hand to strive for maximum protection from proliferation, while on the other promoting the economic advantages of the export of civilian nuclear technology. Despite all of the safety precautions, nuclear proliferation will continue to represent a problem for international security in the future.

With all likelihood, it is not an exaggeration to claim that based on the current and foreseeable state of technology it is impossible to make the civilian use of nuclear energy 100% resistant to proliferation. It is certainly possible to increase the hurdles and to limit the problems. However, all measures proposed to date and which could be undertaken with the aim of containing the problem are likely to lose some of their effectiveness over time. Technological advances and a growing level of access to increasingly high quality technologies will at some point make it easier to attempt to circumvent even improved non-proliferation measures.

Even in the best case scenario, it is to be assumed that the proliferation risks will increase should the number of countries using nuclear energy for electricity production also increase. With each nation joining the civilian nuclear club, there are additional places where nuclear materials need to be safeguarded, additional scientists and experts with specialised training and knowledge who require employment and can further develop the technology, as well as additional locations with installations vulnerable to terrorist attacks.

The risk of proliferation will most probably continue to rise for a variety of reasons:

firstly: uranium is – like gas and oil – a finitely available raw material for energy provision. The world's reserves of uranium will definitely come to an end, no matter whether they last for another 60, 80 or 100 years at a constant level of consumption. Institutions claiming that the reserves of uranium have a long lifespan also mostly assume a rapidly growing number of nuclear power plants in future and, therefore, an equally rapid growth in the consumption of uranium. If uranium is to become a long-term, sustainable energy source then this would require closed fuel cycles and associated technologies like reprocessing and plutonium separation in order for the raw material to be used multiple times. However, reprocessing technology is connected to significantly greater proliferation risks, in particular, when an increasing number of countries build and operate the appropriate facilities.

secondly: a spin-off of globalisation is the weakening of the monopoly held by states on the use of force. This phenomenon is often dealt with using the terms 'failing states' or 'failed states'. In these states, the governments have lost control of certain parts of their territory in which they should be able to maintain security. They can no longer guarantee security there. When these failing states house nuclear facilities, irrelevant of whether they are civilian or military, then this creates a serious proliferation problem. The break-up of the Soviet Union has brought many aspects of this problem to the world's attention that are characteristic of this sort of situation. Can we be sure that Pakistan will never become a failing state or even disintegrate? Is this also true for all of the African states who are currently increasingly considering the use of nuclear energy?

thirdly: there will be an increasing number of countries who can deliver nuclear technology because they will be operating civilian nuclear facilities. This increases the number of technology sources, the scope and quality of the technology transfer and a growing number of countries will gradually find themselves in a position where they can build individual components themselves and also export them. The economic incentives of this type of export business are from experience in many cases quicker to emerge than the construction of an effective export control system and the realisation of improved security standards. The de-industrialisation of the West and the industrialisation of the South will become, therefore, a severe test for today's attempts to control, limit, or deny nuclear technology exports. Some of the

potential future nuclear supplier states may have a different understanding of the legitimate civilian use of nuclear technology than the traditional nuclear powers and their close allies. We need only remember the accusation of 'nuclear apartheid', which has been used to describe the export policies of the Northern hemisphere. This would mean, however, that the systems for controlling nuclear export would also face considerable new challenges. Once new suppliers begin competing for market shares for the first time it is entirely possible that industries in Western nations will turn once again to an old and dangerous argument, which helped to fuel nuclear proliferation during earlier decades: "If we don't sell it, then someone else will. Therefore, it's better for us to sell it ourselves."

A study from the Stockholm International Peace Research institute as far back as 1979 came to the conclusion, when examining the proliferation risks of nuclear energy, that a fuel cycle based on multilateral enrichment and fuel fabrication facilities would represent probably the most effective security against proliferation.[92] The study urged that the two or three decades won by the NPT and other non-proliferation measures should be energetically used to develop such a fuel cycle. Three decades have passed without any significant progress having been made on this proposed path. National economic interests consistently stood in the way. It is only in the last few years – triggered by the debate surrounding Iran – that there has been increased consideration of multilateralism once again.[93] However, it is hard to imagine even today that future proliferation risks will be dealt with in a forward-looking way.

Nuclear energy is still viewed in many countries as a highly valuable, complex and modern technology. Mastering it is seen as proof of technological development and expertise. Therefore, it is regarded in many countries as an important part of development and modernisation. Not all countries possess the economic resources to take this route. But those who do have the means can choose to follow the nuclear option. As long as western countries, who are interested in the profitable export of nuclear facilities and technology, continue to portray nuclear energy as a modern, climate-friendly and inexpensive energy source then this will contribute to other countries starting to use nuclear technology. By acting in this manner, it is inevitable that the risk of proliferation will increase.[94]

The NPT and the non-proliferation regime, created between the 1960s and the beginning of the 21st century, are still underpinned by the same concept of a 'trade off'. The nuclear weapons states promise to disarm their weapons arsenals and the non-nuclear weapons states undertake to not even develop such weapons in the first place – and the unrestricted right to the civilian use of nuclear technology is granted to all member states together. Naturally, it is possible to strengthen non-proliferation or the mechanisms used to prevent proliferation. However, this requires the necessary political will. Whether this political conviction will exist continues to depend on the visible progress made with nuclear armaments control and disarmament. It will also be dependent on whether the civilian use of nuclear technology can be limited or even renounced in countries. This also requires political will. But this has been lacking up to now both in terms of the continued civilian use and also the military use of nuclear technology. The extent to which this political will is lacking is also revealed by the discussions in Germany about extending the lifespan of existing nuclear power stations or even a withdrawal from the already agreed phasing out of nuclear energy.

92 Frank Barnaby et al. (editors): Nuclear Energy and Nuclear Weapon Proliferation. London, Stockholm 1979.

93 Under the supervision of the IAEA, a small multilateral fuel reservoir is to be created upon which member states can draw.

94 It is worth looking at the possibility of portraying nuclear energy increasingly as an outdated technology and making it clear: in an increasing number of countries, the best technicians, engineers and scientists tend to be working today on increasing energy efficiency or on renewable energies rather than on nuclear technologies.

The civilian and military use of nuclear technology can be considered as Siamese twins. Ultimately, one cannot exist without the other and both hold their own major risks. Only if both were renounced would there be the realistic perspective of turning the vision of a world without nuclear weapons into reality and making this vision permanent. The best and most resistant solution to proliferation would be a 'double zero solution' – the elimination of nuclear weapons and nuclear energy. The most powerful argument against this vision of a nuclear-free world that has been used to date – 'Nobody can guarantee and monitor that no actor continues to build nuclear weapons' – would then cease to be so popular. The elimination of nuclear weapons and nuclear energy is much easier and more efficient to monitor than the exclusive renouncement of nuclear weapons.[95]

The German Physical Society, the oldest and largest national physics association on earth, published a resolution on April 6, 2010.[96] To mark the occasion of the review conference for the NPT in May 2010, the scientists suggested in the resolution that negotiations should be initiated about a nuclear weapons agreement: a treaty should be achieved by 2020 that prohibits and forbids nuclear weapons. A similar initiative in terms of nuclear energy would also be required because it is high time for the phasing out of nuclear technology and it will also take time to implement.

95 If only the military use of nuclear technology was exclusively banned then the knowledge, expertise and technical requirements would 'live on' in the civilian sector; if both uses of nuclear technology were eliminated then the expertise and the experts would slowly 'die out'.

96 cf. http://www.dpg-physik.de/presse/pressemit/2010/dpg-pm-2010-12.html

HEINRICH BÖLL STIFTUNG
PUBLICATION SERIES ON ECOLOGY

Nuclear Weapons Proliferation, Energy Security, and Carbon Emission Reduction: How to Overcome the Civilian-Military Nuclear Dilemma.

By Henry D. Sokolski

Washington D.C., March 2010

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1. Nuclear Weapons Proliferation and Prevention: The Next 20 Years

With the run-up to the Nuclear Nonproliferation Treaty (NPT) Review Conference in May of 2010, major states have focused as never before on reducing existing U.S. and Russian nuclear weapons stockpiles, reversing Pyongyang's nuclear buildup, and stopping Iran's nuclear weapons-related activities. The hope is that each of these efforts will be mutually reinforcing and lead to additional nuclear weapons reduction agreements between not only the United States and Russia, but the world's other nuclear weapons states. Finally, it is hoped that progress in reducing existing nuclear weapons will persuade the world's non-nuclear weapons states to do more to stay clear of dangerous civilian nuclear fuel-making activities and to open their civilian nuclear facilities to more intrusive international inspections.

This set of nuclear hopes, however, is unlikely to be fully realized. Barring regime change in either North Korea or Iran, neither Pyongyang's renunciation of its nuclear arsenal nor Iran's cessation of nuclear weapons-related activities is all that probable. As for further reductions in existing nuclear arsenals, there may be some strategic weapons reductions (perhaps to as low as 1,000 to 500 warheads) after the United States and Russia agree to the current follow-on to the Strategic Arms Reduction Treaty (START), but further agreements that might capture Russia's much larger number of tactical nuclear weapons are unlikely to come easily or quickly. Russia sees its conventional military capabilities falling further and further behind those of NATO and China. As a result, Moscow is more likely to increase its security reliance on its thousands of tactical nuclear weapons than it is to eliminate or reduce them. Meanwhile, the odds of China, India, Pakistan, North Korea, and Israel agreeing to nuclear warhead reductions seem even more remote.

Assuming that current nuclear trends continue, then the next two decades will test international security as it has never have been tested before. Before 2020, the United Kingdom will find its nuclear forces eclipsed not only by those of Pakistan, but of Israel and of India. Soon thereafter, France will share the same fate. China, which already has enough separated plutonium and highly enriched uranium to triple its current stockpile of roughly 300 nuclear warheads, will likely expand its nuclear arsenal, too. Meanwhile, Japan will have ready access to thousands of bombs' worth of separated plutonium. U.S. and Russian nuclear weapons-usable material stocks

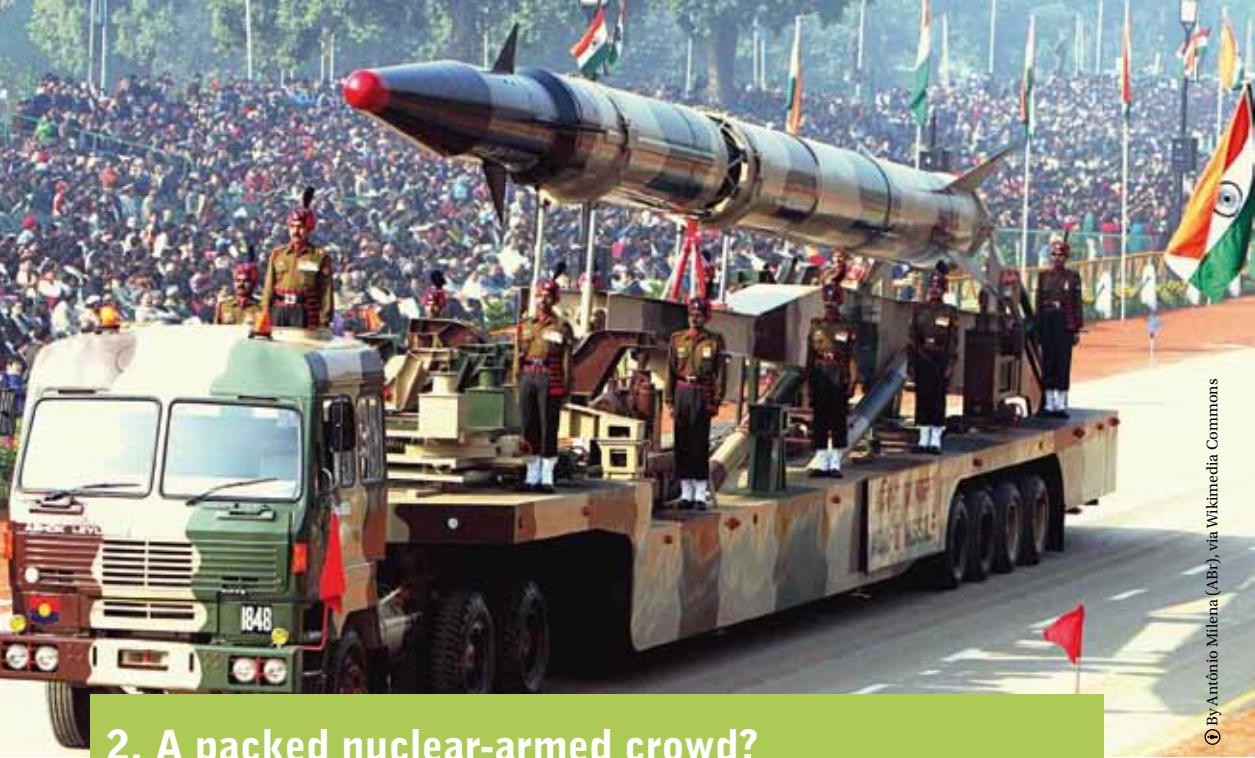
– still large enough to be converted back into many tens of thousands of weapons – will decline only marginally, whereas similar nuclear stores in Japan and other nuclear weapons states could easily double.[1] Compounding these developments, even more nuclear weapons-ready states are likely to emerge: As of 2010, at least 25 states had announced their desire to build large reactors – historically, bomb starter kits – before 2030.

None of this will bolster the cause of nuclear weapons abolition. Compounding these worrisome trends is the growing popularity of "peaceful" nuclear energy. Although almost every nuclear supplier state is now claiming that exporting new power reactors will strengthen nonproliferation, since it will come with the application of "enhanced" nuclear inspections, in many of the most worrisome cases, even enhanced inspections are too unreliable to effectively deter or prevent significant military diversions. As it is, international nuclear inspections are failing to maintain continuity of inspections over most of the world's spent or fresh fuel – materials that can be used as feed for nuclear enrichment and reprocessing-making plants to accelerate the production of weapons-usable materials. These nuclear fuel-making plants, moreover, can be hidden from inspectors and, even when declared, be used to make weapons-usable fuel without nuclear inspectors necessarily detecting such activity in a timely fashion.[2]

Several of these points are beginning to receive attention in the United States. The debate over these matters, though, should be broadened. Indeed, even if Washington's and the EU's favorite nuclear control initiatives (START follow-ons, a Comprehensive Nuclear Test-Ban Treaty (CTBT), Fissile Material Cut-off Treaty (FMCT), civilian nuclear fuel banks, and intrusive nuclear inspections) are all adopted and avoid running the risks noted above, the United States and its allies will still face a series of additional, major nuclear proliferation dangers.

1 International Panel on Fissile Materials, *Global Fissile Materials Report 2008* (October 2008), available at http://www.ipfmlibrary.org/gfmr08.pdf [these and all subsequent urls accessed May 7, 2009]; Andrei Chang, "China's Nuclear Warhead Stockpile Rising", UPIAsia.com (April 5, 2008), available at http://www.upiasia.com/Security/2008/04/05/chinas_nuclear_warhead_stockpile_rising/7074

2 See, e.g., Henry S. Rowen, "This 'Nuclear-Free' Plan Would Effect the Opposite", *Wall Street Journal* (January 17, 2008). For additional technical background, see David Kay, "Denial and Deception Practices of WMD Proliferators: Iraq and Beyond", in *Weapons Proliferation in the 1990s,* ed. Brad Roberts (MIT Press, 1995); Victor Gilinsky, et al., "A Fresh Examination f the Proliferation Dangers of Light Water Reactors" (Washington, DC: NPEC, 2004), available at http://www.npec-web.org/Essays/20041022-GilinskyEtAl-lwr.pdf; and Andrew Leask, Russell Leslie, and John Carlson, "Safeguards As a Design Criteria – Guidance for Regulators", (Australian Safeguards and Non-proliferation Office, September 2004), available at http://www.asno.dfat.gov.au/publications/safeguards_design_criteria.pdf

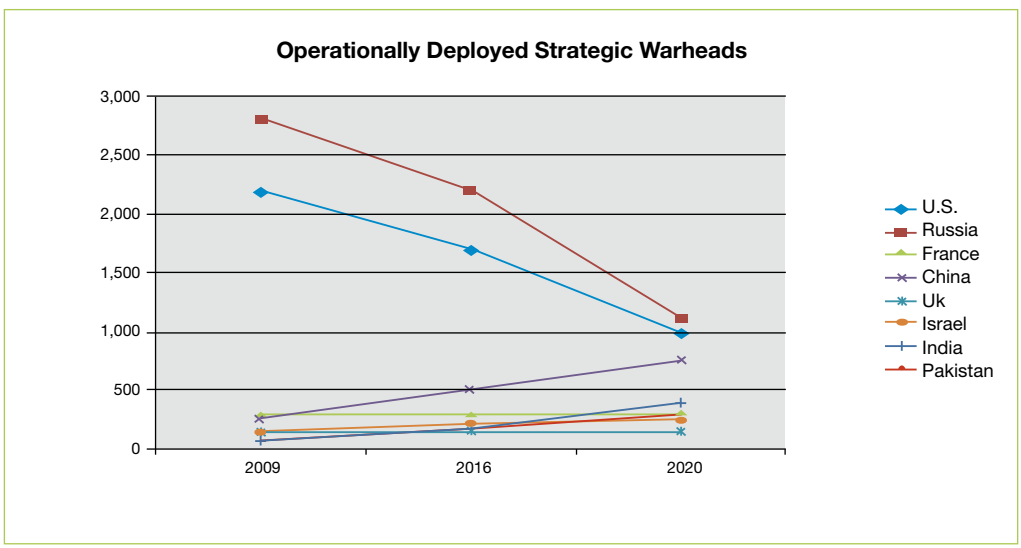


By Antônio Milena (ABr), via Wikimedia Commons

2. A packed nuclear-armed crowd?

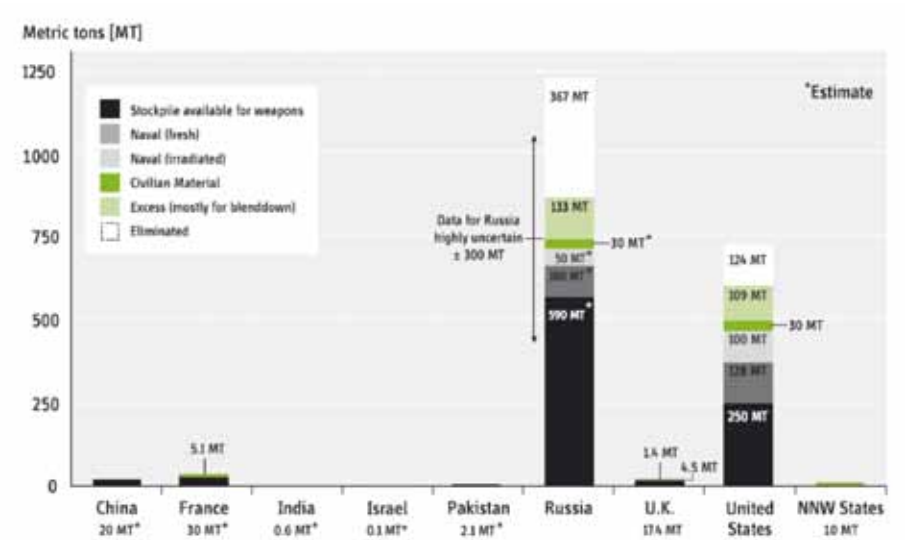
The first of these dangers is that as the United States and Russia incrementally reduce their nuclear weapons deployments, China, India, Pakistan, and Israel are likely to incrementally increase theirs. Currently, the United States is planning to reduce U.S. and Russian strategic weapons deployments to as low as 1,000 warheads each. As a result, it is conceivable that in 10 years' time, the nuclear numbers separating the United States and Russia from the other nuclear weapons states might be measured in the hundreds rather than the thousands of weapons (see figure below). In such a world, relatively small changes in any state's nuclear weapons capabilities would be likely to have a much larger impact on the perceived balance of power than it does today.

Figure 1: Coming Nuclear Congestion[3]



Compounding the international volatility that this set of trends could produce are the large and growing stockpiles of nuclear weapons-usable materials (i.e., of separated plutonium and highly enriched uranium) that are being held in several states. These stockpiles already exceed tens of thousands of crude bombs' worth of material in the United States and Russia and are projected to grow in Pakistan, India, China, Israel, and Japan. This will enable all of these states to increase their current nuclear deployments much more quickly and dramatically than was ever previously possible (see figures below for these states' current holdings).

Figure 2: National stocks of highly enriched uranium as of mid-2009[4]

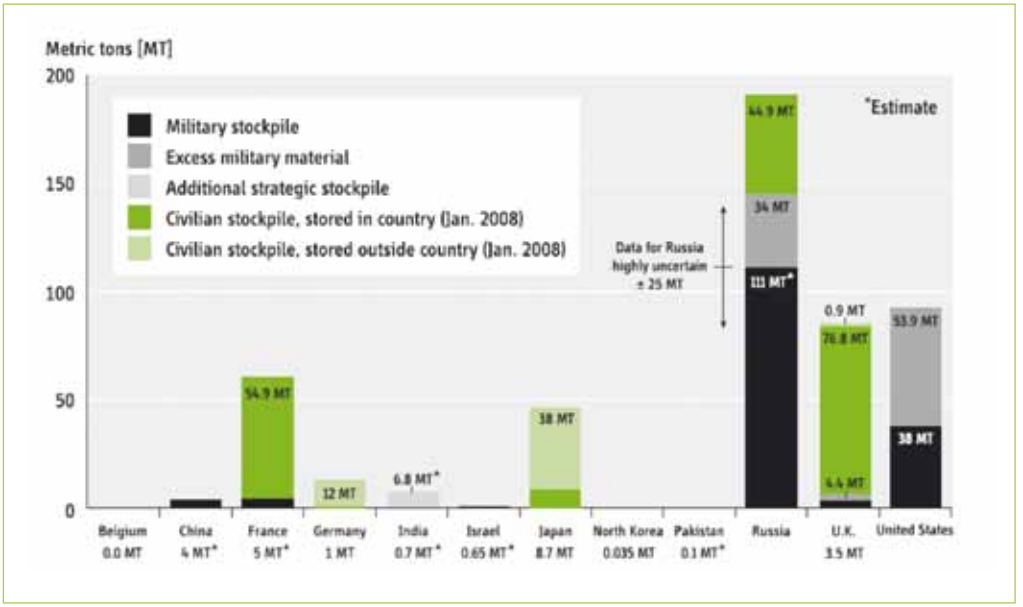


The numbers for the United Kingdom and United States are based on their publications. The civilian highly-enriched uranium stocks of France, the United Kingdom are based on their public declarations to the International Atomic Energy Agency. Numbers with asterisks are non-governmental estimates, often with large uncertainties. Numbers for Russian and U.S. excess HEU are for June 2009. HEU in non-nuclear weapon (NNW) states is under IAEA safeguards. A 20% uncertainly is assumed in the figures for total stocks in China, Pakistan and Russia, and for the miitary stockpile in France, and 50% for India.

3 Data for this chart drawn from the Natural Resources Defense Council, "Russian Nuclear Forces 2007", *Bulletin of the Atomic Scientists* (March/April 2007), available at http://thebulletin.metapress.com/content/d41x498467712117/fulltext.pdf; Gareth Evans and Yoriko Kawaguchi, *Eliminating Nuclear Threats: A Practical Agenda for Global Policymakers* (Canberra, Australia: International Commission on Nuclear Nonproliferation and Disarmament, 2010), p. 20; and Robert S. Norris and Hans M. Kristensen, "U.S. Nuclear Forces, 2008", *Bulletin of the Atomic Scientists* (March/April 2008), available at http://thebulletin.metapress.com/content/ pr53n270241156n6/fulltext.pdf

4 Frank Von Hippel, et al., International Panel on Fissile Material, *Global Fissile Material Report 2009*, pp.13 and 16, available at http://www.fissilematerials.org/ipfm/site_down/gfmr09.pdf

Figure 3: National Stocks of Separated Plutonium[5]



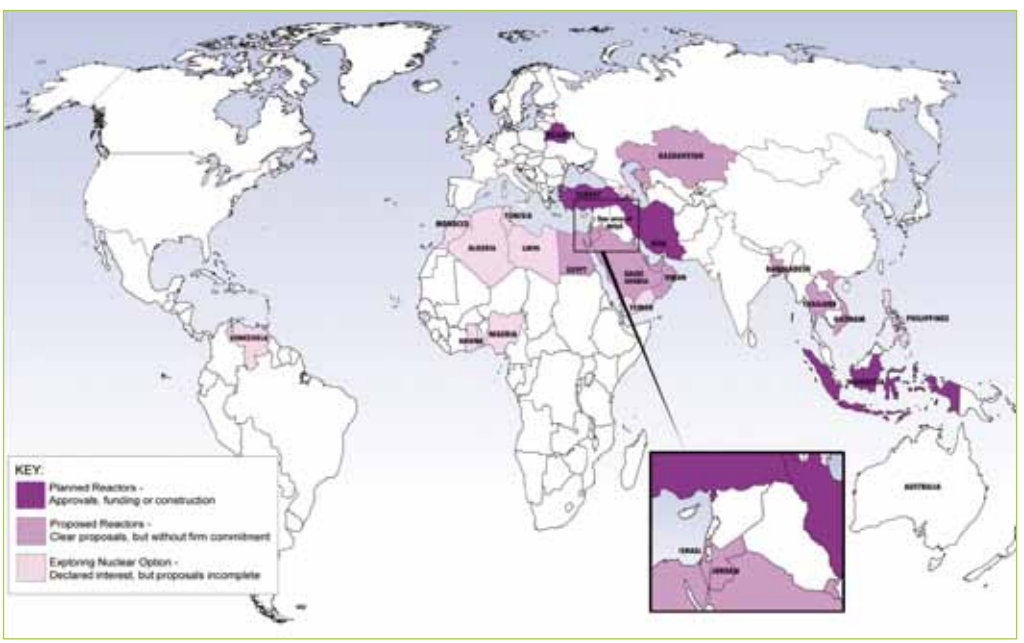
Civilian stocks are based on the most recent INFCIRC/549 declarations for January 2008 and are listed by ownership, not by current location. Weapon stocks are based on non-governmental estimates except for the United States and United Kingdom whose governments have made declarations. Uncertainties of the military stockpiles for China, France, India, Israel, Pakistan and Russia are on the order of 20%. The plutonium India separated from spent heavy-water power-reactor fuel has been categorized by India as "strategic", and not to be placed under IAEA safeguards. Belgium holds 1.4 tons of foreign-owned plutanium, but not stockpile of its own (Appendix 1C).

Finally, in 20 years, there could be more nuclear weapons-ready states – countries that could acquire nuclear weapons in a matter of months, like Japan and Iran. In addition, more than 25 states have announced plans to launch large civilian nuclear programs. If they all realize their dreams of bringing their first nuclear power reactors on line by 2030, it would constitute a near doubling of the 31 states that currently have such programs, most of which are in Europe (see figures 4 and 5).

5 *Ibid.*

Figure 4: Today's States or Regions with Nuclear Reactors[6]

Figure 5: Proposed Nuclear States (2008)[7]



6 Graphs developed for NPEC by Sharon Squassoni. Available at http://www.npec-web.org/Frameset.asp?PageType=Projects
7 Ibid.

If this civilian nuclear expansion is realized, it could have major military implications. Every current weapons state first brought a large reactor on line prior to acquiring its first bomb. The United Kingdom, France, Russia, India, Pakistan, and the United States all made many of their initial bombs from reactors that also provided power to their electrical grids. The United States still uses a power reactor, a 'proliferation resistant' light-water reactor operated by the Tennessee Valley Authority, to make all of its weapons-grade tritium for its nuclear arsenal.

Other plants besides large power reactors, of course, would be needed to chemically separate out weapons-usable plutonium from the spent power-reactor fuel or to enrich the uranium used to power such machines. Yet, as the recent cases of Iran and North Korea demonstrate, such fuel-making plants can be built – and in ways that can be difficult to detect – and operated to make timely detection of illicit production unlikely. Certainly, if all of the announced civilian nuclear power programs are completed as planned, the world in 2030 would be far less stable. Instead of there being several confirmed nuclear weapons states (most of which the United States can claim are either allies or strategic partners) there could be an unmanageable number of additional nuclear weapons-capable states – armed or weapons-ready (i.e., able to acquire weapons in 12 to 24 months) – to contend with, as figures 6 and 7.

Figure 6: Current Nuclear States

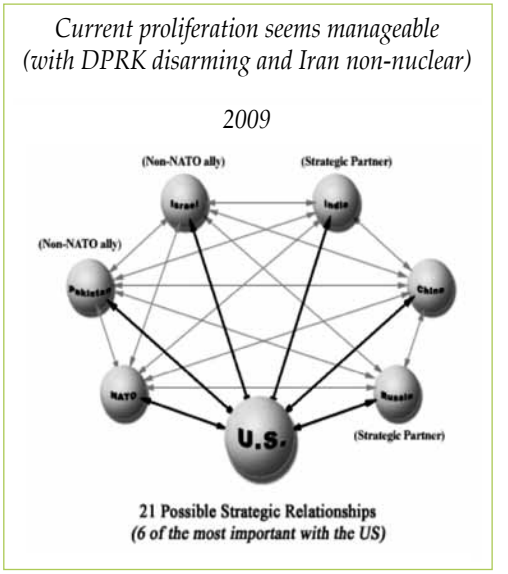
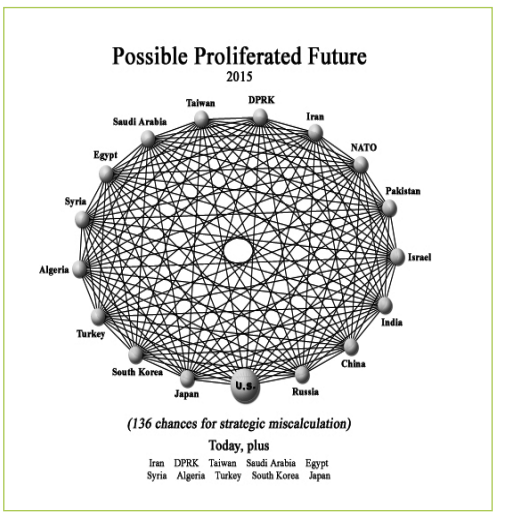


Figure 7: Nuclear-ready States by 2015



In such a world, the United States, its allies and the EU might know who their friends and potential adversaries might be but they would have difficulty knowing what such states might do in a crisis – close ranks, go their own way developing weapons options, or follow the lead of some other nuclear-capable nation. As for possible adversaries, the United States, its allies and the EU would have difficulty determining just how lethal these adversaries' military forces might be.

Finally, these nuclear trends would surely aggravate the prospects for nuclear terrorism. Not only would there be more opportunities to seize nuclear weapons and nuclear weapons materials, there would be more military and civilian nuclear facilities to sabotage. In addition, the potential for miscalculation and nuclear war could rise to a point where even non-nuclear acts of terror could ignite larger conflicts that could turn nuclear.

This sort of international volatility is similar to that which preceded World War One and Two. These were periods in which overly ambitious arms-control objectives were pursued while states completed major covert and overt military preparations that heightened tensions and subsequently were employed in unrestricted warfare. The difference would be that over the next 20 years, the ammunition in these conflicts would not just be highly explosive, but nuclear.

3. Making the most of zero

All of this raises the question of whether or not we can avoid or mitigate these trends. The short answer is yes, but only if we attend more closely to several basic principles.

First, as nuclear weapons deployments decline, more care must be taken to ensure military reductions or additions actually work to decrease the chances for war.

If American and NATO nuclear security-guarantees are to continue in the immediate and mid-term to neutralize the nuclear weapons yearnings of key U.S. allies and NATO members, it is critical that Washington and NATO avoid doing anything to undermine the correlation of forces they currently enjoy against their key nuclear competitors. In addition to making roughly equal nuclear reductions with Russia, then the United States and NATO in the near to mid-term will have to keep other nuclear-armed states, such as China and India, either from trying to catch up with the United States or – as in the case of India and China, Pakistan and India, and Japan and China – with each other.

This means that additional nuclear restraints, either in the form of nuclear weapons reductions or further limits on the production or stockpiling of weapons-usable fuels, will need to be reached not only with Russia, but with China, India, and Pakistan. As a practical matter, this also means that other nuclear weapons-ready or virtual weapons states (e.g., Israel and Japan) will have to be asked to curtail or end their production of nuclear weaponsusable materials or to dispose of some portion of what they currently have.

To date, neither the United States nor the EU have detailed how best to do this. President Barack Obama has called for the negotiation of a Fissile Material Cut-off Treaty. But most versions of this agreement allow "civilian" nuclear fuel production, which is virtually identical to military fuel production. Also, after decades of fruitless negotiations in Geneva, it is unclear if any such agreement could ever be brought into force. Negotiations are currently being held up by the Pakistanis.

There are, however, ways to restrain fissile production outside of negotiating an FMCT. Specifically, some officials, including those advising Secretary of State Hillary Clinton, have suggested a complementary approach known as the Fissile Material Control Initiative. Instead of a binding treaty, both Non-Proliferation Treaty weapons states *and* nonweapons

states would simply identify what portion of their separated plutonium and highly enriched uranium stocks were in excess of either their military *or* civilian requirements and secure or dispose of them.[8] One could also make it more difficult for states to access the surpluses they declare by requiring the prior consent of all parties participating in the initiative for access to be granted.[9]

Yet another practical idea, which would have direct bearing on India's nuclear weapons activities, would be to ensure that the implementation of the U.S. civilian nuclear cooperative agreement with New Delhi does nothing to help India make more nuclear weapons-usable fuels than India was producing when the deal was finalized late in 2008. Under the NPT, the states that had nuclear weapons in 1967 – the United States, Russia, France, the United Kingdom, and China – swore not to ever help any other state to acquire them directly or indirectly. Meanwhile, under the Hyde Act, which authorized the civilian U.S.-Indian nuclear deal, the White House is routinely required to report to Congress on just how much uranium fuel India is importing, how much it is using to run its civilian reactors, how much uranium it is producing domestically, and the extent to which the operation of its unsafeguarded reactors is expanding its stockpiles of unsafeguarded plutonium with either the direct or indirect help of NPT weapons states.[10]

If India's unsafeguarded plutonium stockpiles grow faster per year than was the case prior to the nuclear cooperative agreement's finalization in 2008, and it can be shown to be related to Indian uranium imports from one or more of the NPT weapons states, the later would be implicated in violating Article I of the NPT. To prevent such a violation or, at least, limit the harm it might do, the United States should alert all other nuclear-supplying states and ask that they suspend civilian nuclear assistance until India's unsafeguarded nuclear weaponsusable material production declines. Here, the logical place to make this request would be the Nuclear Suppliers Group. Such vigilance should also be matched with efforts to keep Pakistan from expanding its nuclear weapons capabilities as well.

As for trying to maintain the relative parity in the forces of competing nuclear-armed states through non-nuclear military assistance or buildups, the challenge will be to substitute conventional arms for nuclear ones in a manner that avoids increasing one or both side's interests in acquiring more nuclear weapons. Unfortunately, simply deploying more advanced non-nuclear systems to compensate for forgone nuclear systems will not necessarily assure this.

Consider long-range precision strike and advanced command control and intelligence systems in the case of India and Pakistan. Pakistan believes it must threaten to use its nuclear weapons first to deter India's superior conventional forces. Precision strike systems, however, could conceivably target Pakistan's nuclear weapons. As a result, one could imagine that arming India with such weapons would only put Pakistan on an even higher nuclear alert and encourage Islamabad to acquire even more nuclear weapons to assure that their nuclear forces could not be knocked out by precise Indian conventional strikes. Exporting the wrong kinds of advanced non-nuclear weapons systems in India or helping it to build them in disproportionate numbers could adversely influence Pakistan's nuclear weapons plans.

Ballistic missile defenses could also be tricky. Under the right circumstances, having such

8 See, e.g., Robert Einhorn, "Controlling Fissile Materials and Ending Nuclear Testing", presentation before the International Conference on Nuclear Disarmament, Oslo (February 26–27, 2008), available at http://www.ctbto.org/fileadmin/user_upload/pdf/External_Reports/paper-einhorn.pdf

9 See Albert Wohlstetter, "Nuclear Triggers and Safety Catches", in Nuclear Heuristics: *Selected Writings of Albert and Roberta Wohlstetter*, eds. Robert Zarate and Henry Sokolski (Carlisle, PA: U.S. Army War College Strategic Studies Institute, 2009).

10 See the Henry J. Hyde United States-India Peaceful Atomic Energy Cooperation Act of 2006, *Implementation and Compliance Report*, available at http://frwebgate.access.gpo.gov/cgi bin/getdoc cgi?dbname=109_cong_bills&docid=f:h5682enr.txt.pdf

defenses could afford a non-nuclear form of deterrence that might facilitate reducing the numbers of deployed nuclear weapons. Instead of "neutralizing" a possible opponent's missiles by targeting them with nuclear or non-nuclear offensive weapons, active missile defenses might be used to counter them after launch. They also could be useful as a form of insurance against cheating on any future nuclear-capable ballistic missile reduction agreements. As already noted, to secure these benefits, more than their mere deployment may be necessary.

Again, consider the Indian and Pakistani case. While Pakistan insists it must use its nuclear weapons first in any major war against India, New Delhi is hoping to use its conventional forces to capture enough of Pakistan from a "cold start" to get Islamabad to quickly sue for peace. India has also begun to develop missile defense systems of its own to counter both Pakistani and Chinese offensive missile threats.

Under these circumstances, having equal amounts of missile defenses between India and Pakistan would only give India yet another non-nuclear military edge against Islamabad. This, in turn, risks encouraging Pakistan to beef up its offensive nuclear missile forces even more. The only way to counter this and help to secure the benefits of missile defense for both countries would be to address the underlying conventional asymmetry between them.

One reason regional security experts have long favored creating low, medium, and high conventional deployment zones on both sides of the Indo-Pakistani border is to equalize each side's ability to launch "quick" conventional attacks against one another. A key element of these proposals is that both sides eliminate their existing short-range ballistic missiles, since their use could mistakenly prompt nuclear reactions. If such military confidence-building measures were implemented, they might be effective enough to attenuate the perceived stability risks of deploying more advanced, discriminate, non-nuclear military systems.[11]

Elsewhere, other measures might be required. As China increases its nuclear and non-nuclear missile superiority over Taiwan and its capability to target U.S. carrier battle groups with advanced, conventional ballistic missiles, the United States and its Pacific allies must worry that Beijing may be able to overwhelm the missile defenses they are now working on. China, meanwhile, is developing ballistic missile defenses of its own to counter possible U.S. nuclear and precise conventional intercontinental ballistic missile attacks. Countering offensive Russian ballistic missiles may also be a Chinese concern. All of these missile worries suggest that diplomatic efforts might usefully be focused on reaching offensive ballistic missile limits in Asia to assure that whatever missile defenses are deployed there will not immediately be overwhelmed.

Here, several precedents exist. START, which limits U.S. and Russian strategic ballistic missile delivery systems, is one. The Intermediate Nuclear Forces Treaty, which covers Russian and NATO missiles with ranges between 500 and 5,500 kilometers, is another. The Missile Technology Control Regime (MTCR), which limits commerce in missiles capable of lifting 500-kilogram payloads at least 300 kilometers in range, is another still.

The trick in reaching new additional ballistic missile limits is to make sure they are aggressive enough to capture the ballistic missiles that matter so as to reduce the need or desire to deploy more nuclear warheads without creating new categories of permissible missiles. It certainly would make little sense to eliminate ballistic missiles above 500 kilometers range only to end up legitimizing slightly lower-range missile systems that are above the limits restricted by the MTCR.

11 On these points, see Peter Lavoy, "Islamabad's Nuclear Posture: Its Premises and Implementation", in *Pakistan's Nuclear Future: Worries beyond War*, ed. Henry Sokolski (Carlisle, PA: Strategic Studies Institute, 2008), pp. 129–66; see also General Feroz Khan, "Reducing the Risk of Nuclear War in South Asia", September 15, 2008, available at http://www.npec-web.org/Essays/20090813-khan%20final.pdf

Yet another related concern in limiting offensive ballistic missiles while cutting out a space for the deployment of missile defense systems that employ ballistic missile technology themselves is to make sure the proliferation of missile defenses does not itself result in the further spread of large ballistic missiles or related technology. Here, one might start by prohibiting the export of ballistic missile-based defensive systems that employ rockets in excess of the MTCR's category-one missile limits (i.e., on missiles capable of lifting 500 kilograms more than 300 kilometers). Alternatively, agreements might be reached to encourage states to move away from the employment of missile defense systems that rely on large ballistic missile systems toward alternatives (e.g., drone-based boost phase, space, and directed energy-based systems).

This brings us to the second general principle.

Reducing existing nuclear weapons and nuclear-capable delivery systems should be related more closely to preventing their further spread to additional states.

Currently, the connection between reducing nuclear arms and preventing their spread is mostly symbolic. As the U.S. and Russia reduce their nuclear deployments, other nuclear-armed states, it is argued, ought follow and this, in turn, should persuade non-nuclear weapons states to submit to much more intrusive inspections of their civilian nuclear activities.[12] Putting aside the hard cases of Iran and North Korea, this line of reasoning, however, ignores several key technical developments and turns on several questionable political assumptions.

First, after the International Atomic Energy Agency failed to detect the covert nuclear programs in Iraq, Iran, Syria, and North Korea, it is an open question of whether "enhanced" international nuclear inspections will ever be able to reliably detect future illicit nuclear activities. This is especially so if, as some believe, large civilian nuclear programs spread in regions like the Middle East.

Second, not only the United States but Israel, Japan, NATO, India, Russia, and China are planning to deploy ballistic missile defense systems – each for very different reasons. Yet, U.S. and allied approaches to controlling nuclear strategic threats has been practically silent as to whether these defense programs should be promoted or restricted and, if so, how. Nor has there been, outside of strategic reduction talks with Russia, much discussion as to whether or how other states' development of ballistic missiles (both nuclear and non-nuclear) should be approached.

Then there are political questions. How likely is it that Russia will agree to further nuclear cuts beyond the current START negotiations? Will there be yet another START agreement to lower numbers to 1,000 strategic deployed warheads? Will Russia agree to limit its nonstrategic nuclear weapons? What demands will Moscow make for such reductions? Will Russia demand the United States and NATO cripple their conventional and missile defense plans? Finally, when, if ever, might such agreements be reached? The success of America's and the EU's arms control and non-proliferation policies depend on the answers to these questions being favorable to the United States.

Related to the political issues noted above is the questions of enforcement. If there are no new penalties or risks for developing nuclear weapons-related capabilities, how likely is it that states without nuclear-capable missiles or atomic weapons will keep clear of trying to acquire them? Certainly, the greater Middle East is watching what, if anything, the United States and its allies might do to penalize Iran's nuclear misbehavior. Most states in the region are already hedging their nuclear bets by acquiring "peaceful" nuclear programs of their own. Similar dynamics are in play in the Far East in relation to North Korea's nuclear

12 See, e.g., Gareth Evans and Yoriko Kawaguchi, *Eliminating Nuclear Threats: A Practical Agenda for Global Policymakers* (Canberra, Australia: International Commission on Nuclear Non-proliferation and Disarmament, 2010), pp. 3-36.

weapons program. Beyond these two cases, there is the general worry that the enforcement of nuclear nonproliferation-limits lack any teeth. What, if anything, will be done to prevent further nonproliferation violations?

These many questions all suggest the need for an additional set of arms control and nonproliferation measures to complement the set of arms control measures that the United States and the EU are currently pushing. Why not complement these efforts (which may or may not succeed) by promoting more immediate, incremental limits?

Here, it would be most useful to link efforts to constrain existing nuclear arsenals with preventing their further spread and to link both to efforts of reducing and constraining nuclear-capable ballistic missiles. Several initiatives here would qualify. Instead of waiting for Iran, Pakistan, India, North Korea, and Egypt to ratify the CTBT, why not use the implicit ban on nuclear testing contained in the NPT to secure an immediate agreement among civilian nuclear supplier states to block nuclear trade with any NPT nonweapons state that tests? Once agreement on this has been reached, an additional agreement might be sought to expand such trade restrictions to nuclear weapons states as well.

Why not proceed with the Fissile Material Control Initiative, which would have an immediate (albeit initially modest) impact both on nuclear weapons states and nonweapons states, while pushing the Fissile Material Cut-Off treaty, which would only affect nuclear weapons countries?

Currently, violators of the NPT and IAEA safeguards and states that withdraw from the NPT while still in violation are not prohibited from receiving nuclear-capable missile technology and assistance from missile technology-supplying states. Why not eliminate this loophole with the adoption of an automatic cutoff to goods controlled by the MTCR to these nuclear violators?

States that flaunt the nuclear rules, such as North Korea, are also free to test nuclear-capable missiles outside of their borders. Under current international law, all of this is legal. Yet, such missiles are ideal for carrying nuclear warheads and their development and testing are inherently destabilizing. Should there not be an international norm – as there is with piracy and slave trading – giving states the technical power to shoot such objects out of international air space (e.g., the United States, Russia, Israel, and soon Japan, NATO, and China) as with "outlaw" objects? If progress is made on creating additional limits on ballistic missile deployments (e.g., a global Intermediate Nuclear Forces Treaty), should violators of these understandings not also be banned from receiving controlled missile and controlled nuclear goods and be subject to similar missile testing restrictions?

Of course, nuclear proliferation to additional states will continue so long as nuclear inspections are seen as a solution to preventing such spread when, in many important cases, they cannot be relied upon. To do better, a third principle will need to be applied.

International nuclear inspectors should be encouraged to distinguish between nuclear activities and materials that they can reliably safeguard against being diverted to make bombs and those that they cannot.

The NPT is clear that all peaceful nuclear activities and materials must be safeguarded – that is, inspected in a manner that can reliably prevent them from being diverted to make nuclear weapons. Most NPT states have fallen into the habit of thinking that if they merely declare their nuclear holdings and allow international inspections, they have met this requirement.

This is dangerously mistaken. After the nuclear inspection gaffes in Iraq, Iran, Syria, and North Korea, we now know that the IAEA cannot reliably detect covert nuclear activities early enough to allow others to intervene to prevent possible bomb-making. We also now know that inspectors annually lose track of many bombs' worth of nuclear weapons-usable plutonium and uranium at declared nuclear fuel-making plants. Privately, IAEA officials admit that the agency cannot assure

continuity of inspections for spent and fresh fuel rods at more than half of the sites that it inspects. Finally, we know that declared plutonium and enriched uranium can be made into bombs and their related production plants diverted so quickly (in some cases, within hours or days) that no inspection system can offer timely warning of a bomb-making effort. Yet, any true safeguard against military nuclear diversions must reliably detect them early enough to allow outside powers to intervene to block a bomb from being built. Anything less is only monitoring that might, at best, detect military diversions *after* they occur.

In light of these points, it would be useful for the IAEA to concede that it cannot safeguard all that it inspects against possible military diversions. This would finally raise first-order questions about the advisability of producing or stockpiling plutonium, highly enriched uranium, plutonium-based reactor fuels, and believing that these materials and activities can be safeguarded. At the very least, it would suggest that nonweapons states ought not to acquire these materials or facilities beyond what they already have. These points are important enough to raise before, during, and after the May 2010 NPT Review Conference. In this regard, the United States and other like-minded nations might independently assess whether or not the IAEA can meet its own inspection goals; under what circumstances (if any) these goals can be met; and, finally, whether these goals are high enough. The U.S. House of Representatives last year approved legislation to require the executive to make such assessments routinely and to report their findings. Similar legislation has been proposed in the Senate.[13]

Finally, to assure safe, economically competitive forms of clean energy, greater attention should be paid to comparing costs and discouraging the use of government financial incentives for commercialization projects, especially nuclear power.

Supporters of nuclear power insist that its expansion is critical to prevent global warming. Yet, they generally downplay or ignore the nuclear weapons proliferation risks associated with this technology's further spread. That said, it may be impossible to prevent the spread of nuclear power if it turns out to be a cheap and convenient way to provide low-carbon energy. Given the security premium associated with the further spread of nuclear power technologies, though, no government should pay extra to promote it and no government should support other governments doing so.[14]

Certainly, creating new, additional government financial incentives specifically geared toward building more commercial nuclear plants and their associated fuel-making facilities will only increase the difficulty of accurately comparing it with non-nuclear alternatives. Not only do such subsidies mask nuclear power's true costs, they tilt the market against less subsidized, potentially sounder alternatives. This is troubling since nuclear power continues to enjoy massive government support and the most dangerous forms of civilian nuclear energy – nuclear fuel-making in most nonweapons states and large power reactor projects in war-torn regions like the Middle East – turn out to be poor investments as compared to much safer alternatives.[15]

13 See Section 416 of the House State Authorization Act of 2010 and 2011 "Implementation of`Recommendations of Commission on the Prevention of WMD Proliferation and Terrorism", available at http://www.govtrack.us/congress/billtext.xpd?bill=h111-2410

14 As the re-launch of German export credits ("Hermes") for nuclear power generation in Brazil, Russia, and China or President Sarkozy's proposals to finance nuclear power with development funds and loans.

15 See, e.g., Peter Tynan and John Stephenson, "Nuclear Power in Saudi Arabia, Egypt, and Turkey – how cost effective?" February 9, 2009, available at http://www.npec-web.org/Frameset.asp?PageType=Single&PDFFile= Dalberg-Middle%20East-carbon&PDFFolder=Essays; "Frank von Hippel, "Why Reprocessing Persists in Some Countries and Not in Others: The Costs and Benefits of Reprocessing", April 9, 2009, available at http://www.npec-web.org/Frameset.asp?PageType=Single&PDFFile=vonhippel%20%20TheCostsandBenefits&PDFFolder=Essays; Doug Koplow, "Nuclear Power as Taxpayer Patronage: A Case Study of Subsidies to Calvert Cliffs Unit 3", available at http://www.npecweb.org/Frameset.asp?PageType=Single&PDFFile=Koplow%20-%20CalvertCliffs3&PDFFolder=Essays

There are several ways to avoid this. The first would be to get as many governments as possible to open up all large civilian energy projects in their countries to international competitive bidding. This is already done in a number of countries. The problem is that when states want to build large civilian nuclear reactors, they limit the competition to nuclear bids rather than open the competition to any energy option that could meet a given set of environmental and economic criteria. Limiting the competition in this way ought to be discouraged internationally.

Most advanced nations, including the United States, claim to back the principles of the Energy Charter Treaty and the Global Charter on Sustainable Energy Development. These international agreements are designed to encourage all states to open their energy sectors to international bidding to assure that all energy options are considered and that as many subsidies and externalities associated with each are internalized and reflected in the price of what is being proposed. Promoting adherence to these rules is essential if the United States and other states are serious about reducing carbon emissions in the quickest, least costly manner.

Here, one might reference and enforce the principles of the Energy Charter Treaty and the Global Charter on Sustainable Energy as a part of any follow-on to the understandings reached at Kyoto and Copenhagen. In addition, states that choose to build a nuclear plant when less-costly non-nuclear alternatives would clearly make more sense ought to be flagged by an economic competitiveness monitoring body (e.g., the World Trade Organization) that might assume responsibility for overseeing large international energy project transactions. Finally, such uneconomic nuclear picks (e.g., several proposed Middle Eastern nuclear projects) might also be referred to the IAEA for further investigation regarding the project's true purpose.[16]

As a complementary effort, the world's advanced states could also work with developing countries to create non-nuclear alternatives to address their energy and environmental needs. In the case of the United States, this would entail implementing existing law. Title V of the Nuclear Nonproliferation Act of 1978 requires the executive branch to do analyses of key countries' energy needs and identify how these needs might be addressed with non-fossil, non-nuclear energy sources. Title V also calls on the executive branch to create an alternative energy cadre to help developing nations explore these alternative options. To date, no U.S. president has chosen to implement this law. The U.S. Congress has indicated that it would like to change this by requiring Title V country energy analyses (and outside, nongovernmental assessments of these analyses) to be done as a precondition for the U.S. initialing of any new, additional U.S. nuclear cooperative agreements.[17] The United Nations, meanwhile, has an alternative, renewable (non-nuclear) energy initiative of its own aimed at assisting developing states. As with most of the other suggestions already made, the United States and other states can emphasize these initiatives without waiting for any international treaty agreement.

16 For more on these points, see Henry Sokolski, "Market Fortified Non-proliferation", in *Breaking the Nuclear Impasse* (New York, NY: The Century Foundation, 2007), pp. 81–143, available at http://nationalsecurity.oversight.house.gov/documents/20070627150329.pdf
For more on the current membership and investment and trade principles of the Energy Charter Treaty and the Global Energy Charter for Sustainable Development, go to http://www.encharter.org and http://www.cmdc.net/echarter.html

17 See Letter from Members of Congress Brad Sherman, Edward Markey, and Ileana Ros-Lehtinen to Secretary of State Hillary Clinton April 6, 2009 available at http://bradsherman.house.gov/pdf/NuclearCooperationPresObama040609.pdf

CONCLUSION

With states' growing concerns about energy security and reducing carbon emissions, governments have again gravitated toward supporting the expansion of civilian nuclear power. The United States, France, Russia, China, Japan, South Korea, India, Pakistan, Brazil, and a host of other developing states in the Middle East and Asia are now planning on exporting or buying power-reactor programs using state funds and financing.

Yet, in all this, far too little attention has been paid to how one can increase the amount of large reactor programs without also spreading the means to make nuclear weapons. Technically, what is required to boil water with nuclear energy is virtually identical to the means required to make scores of bombs' worth of weapons-usable plutonium.

As a practical matter, one cannot train the hundreds of engineers and technicians required to build and operate such programs without running the risk that they might also learn how to make the fuel necessary by recycling their spent fuel. Nor is it possible to verify effectively the pledges that states might make to forswear making nuclear fuel. Not only has the IAEA failed in the past to find covert nuclear fuel-making plants, but it has repeatedly discovered that it missed accounting for many bombs' worth of separated plutonium and enriched uranium well after it was produced. No proposed system of inspections, including the additional protocol, sufficiently addresses these problems. As a result, unless one is convinced that a state is out of the bomb-making business, transferring to it the means to conduct a large nuclear reactor program runs the significant risk of nuclear weapons proliferation.

If it was clear that states had no choice but to acquire large nuclear reactors to meet their energy security or scientific research demands while reducing their carbon footprints, one would have to be resigned to these risks. Ever more states would become nuclear weaponsready and instead of moving closer to zero nuclear weapons and reducing the threats of nuclear use, the world would drift ever closer to realizing them.

Fortunately, there are several plausible, clean, economically competitive non-nuclear energy options and nuclear threat-reduction measures beyond those being currently promoted that offer hope that we can avoid this civilian-military nuclear dilemma. New discoveries of natural gas are making this relatively clean and inexpensive fuel a possible bridge to more complicated, and currently more expensive, alternative energy options. The costs of these non-nuclear alternatives, moreover, are dropping. Finally, energy efficiencies, new modes of electrical storage, and distribution systems promise significant reductions in the amount of energy required to produce a given unit of gross domestic product.

The key trick in promoting these non-nuclear energy options over nuclear power will be to compete them economically in open bidding for all large energy projects internationally. Instead of holding competitions for specific energy programs – for example, calling for international bids for a nuclear power plant or a carbon sequestration program – states should be encouraged to hold competitions that only specify the amount of power needed and the environmental requirements that must be met. What we are interested in is promoting the quickest, least costly (assuming the costs of government subsidies, a range of possible prices on carbon, etc., are internalized) way to meet the stated requirements.

Finally, it is imperative that the states most concerned about reducing existing nuclear threats complement their existing list of formal treaty efforts – which may take years, if ever, to be realized – with more practical steps that can be taken now. Among these are encouraging states to reduce their production of weapons-usable fissile materials for civilian or military purposes by getting them to announce that some amount of their existing holdings is in excess of their civilian or military requirements and then getting them

to dispose of this material or make it far more difficult to access. Also, more should be done to assure civilian nuclear fuel sales to non-NPT states, such as India, so that they do not end up fueling nuclear competitions like the one between Pakistan and India.

Nuclear supplier states should also encourage greater candor about the shortcomings of the IAEA nuclear safeguards system and help in clarifying that which nuclear inspections cannot be expected to detect reliably. Finally, it is imperative that greater care be taken regarding the deployment of non-nuclear systems to reduce states' interests in acquiring or relying on nuclear ones. Here, more should be done to limit offensive, nuclear-capable ballistic missiles.

The advantage of these recommendations is that they can be acted upon now. On the other hand, there are no deadlines for their implementation. In these matters, as with any important problem set, all that is required is to begin.

GLOSSARY AND LIST OF ABBREVIATIONS

BWR	Boiling water reactor
CCGT	Combined cycle gas turbine
CEGB	Central Electricity Generating Board
COL	Construction and Operating License
CTBT	Comprehensive Nuclear Test-Ban Treaty
DOE	U.S. Department of Energy
EIA	Energy Information Administration
EPACT	Energy Policy Act
FBR	Fast breeder reactor
GCR	Gas-cooled reactor
GDA	Generic Design Assessment program
HWR	Heavy water reactor (including Candu)
IAEA	International Atomic Energy Agency
IDC	Interest during construction
MTCR	Missile Technology Control Regime
NII	Nuclear Installations Inspectorate
NINA	Nuclear Innovation North America
NPT	Nuclear Nonproliferation Treaty
NRC	U.S. Nuclear Regulatory Commission
O&M	Operations and maintenance
Overnight cost	The construction cost of a nuclear plant including the cost of the first fuel load but excluding any financing charges
PIU	Performance and Innovation Unit
PWR	Pressurized water reactor
RBMK	(Russian reactor design using graphite and water)
START	Strategic Arms Reduction Treaty
Turnkey	A fixed price contract covering the design and construction of the entire plant
WWER	Russian Pressurized water reactor

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The danger of nuclear proliferation is growing in proportion to the number of new nuclear power stations all over the world. There is no insurmountable division between the civil and military use of this technology in spite of the efforts on the part of the International Atomic Energy Agency (IAEA) to regulate this. The most recent example is Iran. At the end of the day anyone who does not want to be regulated cannot be forced to do so. With the expansion of nuclear energy there is a growing necessity to build reprocessing plants and fast breeders in order to produce nuclear fuel. Both give rise to the circulation of plutonium leading in turn to the creation of huge amounts of fissile material capable of making bombs – a horror scenario! With the run-up to the Nuclear Nonproliferation Treaty (NPT) Review Conference in May of 2010, major states have focused as never before on reducing existing U.S. and Russian nuclear weapons stockpiles, reversing Pyongyang's nuclear buildup, and stopping Iran's nuclear weapons-related activities. The hope is that each of these efforts will be mutually reinforcing and that progress in reducing existing nuclear weapons will persuade the world's nonnuclear weapons states to do more to stay clear of dangerous civilian nuclear fuel-making activities. This set of nuclear hopes, however, is unlikely to be fully realised. Barring regime change in either North Korea or Iran, neither Pyongyang's renunciation of its nuclear arsenal nor Iran's cessation of nuclear weapons-related activities is all that probable. Meanwhile, the odds of China, India, Pakistan, North Korea, and Israel agreeing to nuclear warhead reductions seem even more remote. Assuming that current nuclear trends continue, then the next two decades will test international security as it has never have been tested before.

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