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The Permanent Nth Country Experiment

Nuclear Weapons Proliferation in a Rapidly Changing World

"The purpose of the so-called 'Nth Country Experiment' is to find out if a credible nuclear explosive can be designed, with a modest effort, by a few well-trained people without contact with classified information. The goal of the participants should be to design an explosive with a militarily significant yield. A working context for the experiment might be that the participants have been asked to design a nuclear explosive which, if built in small numbers, would give a small nation a significant effect on their foreign relations."

Operating Rules
for the Nth Country Experiment
1964

by

Mycle Schneider
International Consultant on Energy and Nuclear Policy

Paris, March 2007

Commissioned by

The Greens | European Free Alliance in the European Parliament

Contents

Introduction

I made one great mistake in my life... when I signed the letter to President Roosevelt recommending that atom bombs be made.

Albert Einstein

In any room where a file case can be stored, in any district of a great city, near any key building or installation, a determined effort can secrete a bomb capable of killing a hundred thousand people and laying waste every ordinary structure within a mile.

Edward U. Condon
President of the American Physical Society, 1946

In May 1964, just prior to China exploding its first nuclear bomb, a US nuclear weapon laboratory in Berkeley, later to be called Lawrence Livermore National Laboratory, approached two post doctorate physics students for a very particular experiment. They were handed a document called the "Operating Rules" that had a "secret" stamp on every single page and whose first paragraph read:

> "The purpose of the so-called 'Nth Country Experiment' is to find out, if a credible nuclear explosive can be designed, with a modest effort, by a few well-trained people without contact with classified information. The goal of the participants should be to design an explosive with a militarily significant yield. A working context for the experiment might be that the participants have been asked to design a nuclear explosive which, if built in small numbers, would give a small nation a significant effect on their foreign relations."[1]

The inexperienced scientists had no idea about nuclear physics, let alone nuclear weapons. Dave Dobson and David Pipkorn, later replaced by Bob Selden, were "picked out of the sky", as Dobson put it later, precisely because they were "nuclear innocents".

Two and a half years later, on 14 December 1966, the two young men delivered. They presented their design to the cream of the US Manhattan Project scientists who confirmed that the bomb would work. It would be too big to serve as a missile warhead but small enough to be delivered by airplane or truck.

While the 4-page bibliographical reference list of the Nth Country Experiment report, although by definition only drawn from open literature, remains classified until today, a key document has been identified.

Published by the US War Department only days after Hiroshima and Nagasaki were turned to ashes, Smyth's *A General Account of the Development of Methods of Using Atomic Energy for Military Purposes Under the Auspices of the United States Government* "was just what it claimed to be", writes the Bulletin of the Atomic Scientist. "This 40-cent, 182-page paperback served as a project-management manual for designing and building the bomb."

H.D. Smyth, Chairman of the Princeton University's Physics Department and a "consultant" to the Manhattan District US Corps of Engineers, wrote his stunning account at the request of General Groves, military mastermind of the "Manhattan Project".

[1] see Dan Stober's superb account of the Nth Country Experiment in „No experience necessary“, published by the Bulletin of the Atomic Scientist, March/April 2003

Smyth concludes by stating:

> "The end of June 1945 finds us expecting from day to day to hear of the explosion of the first atomic bomb devised by man. All the problems are believed to have been solved at least well enough to make a bomb practicable. (…) Although we do not know when the explosion will occur nor how effective it will be, announcement of its occurrence will precede the publication of this report. (…) A weapon has been developed that is potentially destructive beyond the wildest nightmares of the imagination; a weapon so ideally suited to sudden unannounced attack that a country's major cities might be destroyed overnight by an ostensibly friendly power."

Sixty years later, Smyth's book is available on eBay for $ 6.99. And the "wildest nightmares of the imagination" remain with us.

The Nth Country Experiment continues into the 21st Century. For months there has been hardly a day without Iran or North Korea on the front page of the newspapers. The nuclear weapon test by North Korea on 7 October 2006 has spurred fears of an escalation of cold war rhetoric into hot war reality. For many years the issue of nuclear weapons proliferation has remained confined to small expert circles, although a surprisingly large number of countries had engaged at some point down the weapons path (see Annex 1). It is the George Bush administration's fruitless search for weapons of mass destruction in Iraq that has shed some light on some of the actors that usually remain behind the scenes: nuclear weapons inspectors, military experts and defence officials. The 2005 Nobel Peace Prize for Mohamed ElBaradei, Secretary General of the International Atomic Energy Agency (IAEA) in Vienna, and his organisation has added to the public attention on the issue. The Nobel Prize Committee decision was also a clear declaration against nuclear weapons (see Annex 2).

Nevertheless, in spite of broad media coverage the public understanding of non-proliferation issues remains remarkably low. Why is there no difference in principle between civil and military nuclear systems? Could terrorists build a nuclear weapon? What is the IAEA's role? What are basic duties and rights under the Non-Proliferation Treaty? How is it possible that Iran still is a shareholder in the EURODIF uranium enrichment plant in France but shall not proceed with uranium enrichment in Iran? Who knows that most of the countries that operate nuclear power plants, including the European States Spain, Sweden and Switzerland, at some point in time, had secret nuclear weapons programs?

The present document attempts to lift some of the smokescreen, repair some of the misconceptions and highlight possible counter-proliferation approaches.

• *Energy & Bombs: Two Faces of the Same Coin*

The use of nuclear energy requires extensive scientific and technical knowledge and expertise. From fundamental nuclear physics and chemistry, to extensive applied thermo-hydraulics, via numerous specific interdisciplinary areas like material science and computer based control-command systems, most nuclear countries have trained several hundred to thousands of technicians and engineers that contribute to the nuclear knowledge base.

While military applications need some very specific areas of scientific and technical competence that are linked to warhead design and delivery, the underlying basic nuclear physics and chemistry is identical. There is a big difference though between sophisticated, large nuclear weapons programs like in the major Nuclear Weapon States and the basic design capacity for a single nuclear device or a small number of weapons. The available delivery technique is an important parameter. Miniaturisation like in multiple warhead systems – a single missile delivers several warheads that can separately and simultaneously attack different targets – or in short range, small tactical nuclear weapons needs very sophisticated design capacities. It is highly unlikely that any sub-national group would be in a position to acquire the necessary information, materials and building capabilities for such sophisticated designs. On the other hand, the development of a crude nuclear device is well within reach of a sub-national group, as the Nth Country Experiment demonstrated already 40 years ago.

• Two Ways to the Bomb

The key ingredient for a nuclear explosive device is fissile material. As far as known, the only fissile materials that have been used for the manufacturing of nuclear weapons are uranium and plutonium.[2] The Hiroshima bomb was made with uranium and plutonium was used in the bomb that destroyed Nagasaki. The most complex part of the way to the bomb is the generation of the necessary amounts of fissile material. The minimum amount for a nuclear weapon is a critical mass that is the amount of nuclear material necessary to initiate a self-sustaining chain reaction. In the case of uranium, the critical mass (about 2.5 kg and over 60 kg) is much larger than in the case of plutonium (about 1 kg to some 35 kg). There is no absolute value for a critical mass since it is highly dependent on a number of technical factors including especially the fissile content of the material. The higher the fissile content, the lower the critical mass. The application of a neutron reflector can also reduce the critical mass by a factor of three to five (see figures 1 and 2).

The Uranium Path

Natural uranium as it appears in nature contains only a very small fraction of the fissile isotope uranium-235. It is impossible to build a nuclear explosive device on the basis of natural uranium. In order to be weapons usable, the fissile uranium content has to be enriched to levels significantly exceeding 20% U-235, a level that is considered improper for weapons use. However, even enrichment levels of around 40% U-235 would necessitate very large quantities of uranium (see figures 1 and 2).

Uranium enrichment is a very complex and energy consuming process. First the natural uranium ore has to be transformed in a uranium mill into concentrate, often called yellow cake (U_3O_8), because of its colour. After, the material is generally converted into uranium hexafluoride (UF_6), which serves as feed material for uranium enrichment plants. Out of a number of technical possibilities, including chemical enrichment and laser isotope separation, there are essentially two technologies that have been used on a large scale, gaseous diffusion (like the international EURODIF plant based in France) and centrifuges (like the European URENCO with plants in the UK, the Netherlands and Germany). Currently there are only a limited number of countries that master the enrichment technology and that operate enrichment facilities.

In the case of a typical light water reactor that uses low enriched uranium (around 4%), the process from mine to reactor turns 20,000 t of uranium ore into some 25 t of fuel. Incidentally, this sheds also sheds some light on the amount of waste produced in the process.

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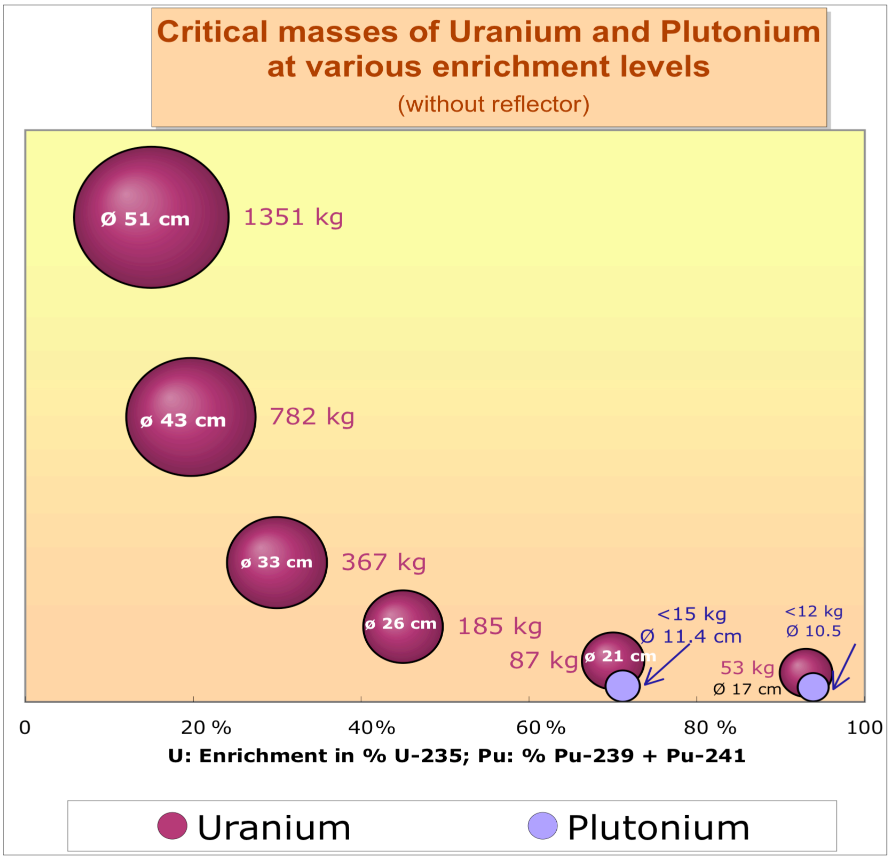
[2] Theoretically, thorium that is occurring in significant quantities in nature, could be used to "breed" uranium-233, which is also fissile and could be used in nuclear weapons. Only the US is known to have tested U-233 designs. But there is no public information indicating that any of the Nuclear Weapon States have actually built and exploded americium-241 or neptunium-237 devices, which theoretically could also be designed.

In the case of a nuclear weapon, the uranium has to be further enriched, typically to over 90%. While it is a matter of choice to operate an enrichment facility for civil or military purposes once it is there, it is a major time consuming, technical and economical investment to start with.

The Plutonium Path

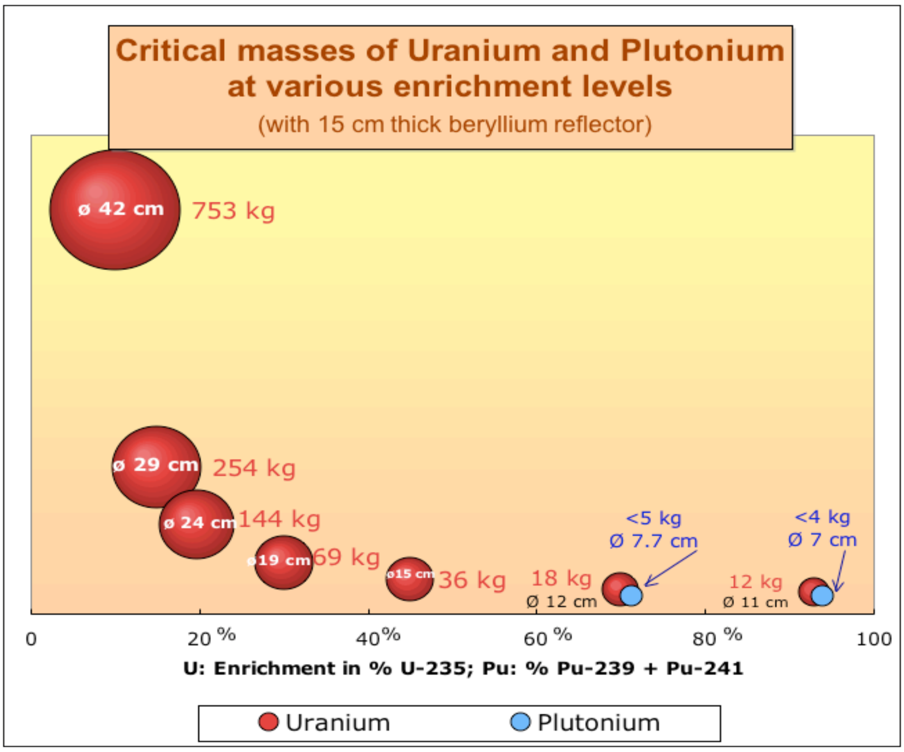
Most of the nuclear weapons in the world contain plutonium as key ingredient. Plutonium is generated as a by-product in every nuclear reactor. As a rule of thumb, spent light water reactor fuel contains about 1% of plutonium and a typical 900 MW reactor generates about 250 kg of plutonium per year. A dedicated plutonium production reactor, depending on its size and operational characteristics, would generally produce much smaller amounts of plutonium – less than 0.5 kg or **<** 0.05% per tonne of fuel. In the case of the UK Magnox reactors, for example, that would turn out to less than 50 kg per year. But this plutonium would be of excellent weapons quality that is around 97% of the fissile content (isotopes Pu-239 and Pu-241). Plutonium of such isotopic purity is also called "super grade" plutonium and allows to reach extremely small critical masses and therefore the miniaturisation of the warheads as needed in modern missiles.

Figure 1: Critical Mass and Size of Fissile Material (in kg and cm diameter, no reflector)



MYCLE SCHNEIDER CONSULTING *Source : derived from [Glaser 2005]*

Figure 2: Critical Mass and Size of Fissile Material (in kg and cm diameter, with reflector)



MYCLE SCHNEIDER CONSULTING *Source : derived from [Glaser 2005]*

Plutonium is characterised as either weapon grade, fuel grade, or power reactor grade based on the percentage of Plutonium-240 that is contained in the plutonium. Weapon grade plutonium contains less than 7 percent Pu-240. Fuel grade plutonium contains from 7 percent to less than 19 percent Pu-240, and power reactor grade contains from 19 percent and greater Pu-240. The quality of the plutonium has great impact on the critical mass (see graphs 1 and 2) – and therefore on the necessary quantity of material for a nuclear weapon – and on size and predictability of the weapon.

A plutonium disk in a glove box

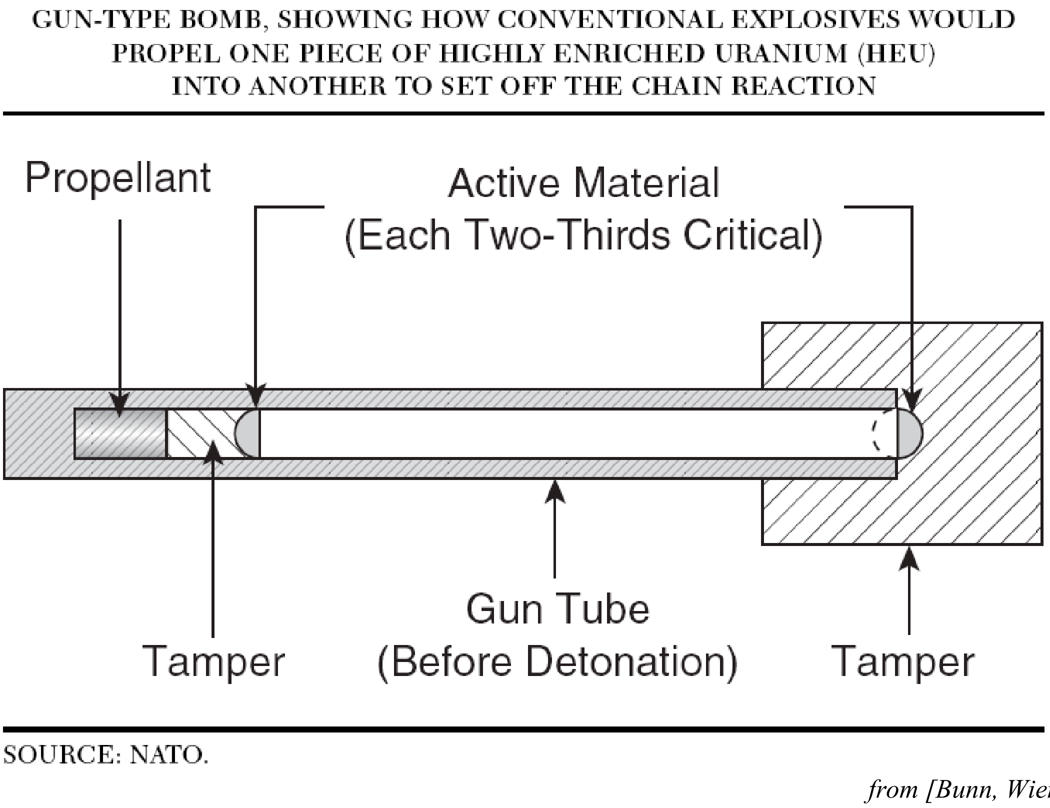
In order to make use of plutonium, it has to be separated from the spent fuel. This is done in so-called reprocessing plants, which are complex chemical facilities that chop up the fuel rods and extract the plutonium and remaining uranium with the help of nitric acid followed by a multi-step process. Commercial reprocessing plants are very large nuclear complexes that are designed to treat hundreds of tons of spent fuel per year and correspondingly put through several tons of plutonium annually. Small quantities of plutonium can be separated in miniaturised facilities, "hot cells" that allow distant manipulation. Spent nuclear fuel is very radioactive. Typical used commercial fuel, if unshielded, delivers a lethal dose in one-meter distance in about one hour. It is therefore impossible to get into direct contact with such material.

Nuclear Weapon Designs

Once a proliferator has access to the necessary quantity and quality of fissile material - "90% of the overall difficulty in making a nuclear weapon", according to the US Department of Defence - he has several basic design choices for a nuclear weapon. Some are very simple, significantly easier than the design picked by the Nth Country Experiment. A gun-type weapon that the Manhattan Project chose for the Hiroshima bomb is broadly considered relatively easy to manufacture. Two nuclear weapons experts from Harvard University point out [Bunn, Wier 2006]:

> The detonation of a gun-type bomb is very simple [see Figure 3]. First, chemical explosives detonate, shooting one piece of HEU [high enriched uranium] toward another. When the pieces are close enough together, they become critical; when they meet, they are substantially supercritical. (To get a good explosive yield, typical gun-type bombs include enough material to constitute two to three critical masses.) After neutrons begin the nuclear chain reaction, the reaction accelerates exponentially, so that each "generation" of fission splits more atoms and releases more energy than the one before.

Figure 3: Gun-type nuclear weapon



from [Bunn, Wier 2006]

A gun-type design would use uranium rather than plutonium. The Hiroshima bomb contained about 60 kg of uranium of which less than 2% (about 1 kg) fissioned. Using plutonium would create the big risk that the weapon would blow apart before it reaches any significant yield, because the rate of spontaneous fission could start the chain reaction prematurely.

The design chosen by the Nth Country Experiment is a plutonium-based implosion weapon. In fact, the two young, ambitious nuclear guinea pigs purposely had chosen a Nagasaki type design, more complicated to elaborate than the uranium gun-type weapon. "The development of the implosion method seemed to be a more sophisticated, challenging, and hence appealing problem", wrote the post doc students in their report.[3]"It was a career-enhancing move: The gun bomb was too simple a project to build a reputation on", sums up the *Bulletin of the Atomic Scientist*.[4]

An implosion design uses chemical high explosives that, when detonated produce an implosion wave, which in turn compresses a sphere of plutonium or uranium into a supercritical mass. An implosion weapon needs very small quantities of fissile material. The Nagasaki bomb contained about 6 kg of plutonium – a quantity that would fit into a coke can [Bunn, Wier 2006] – of which about 15% (1 kg) fissioned.

Figures 1 and 2 illustrate how by the simple addition of a neutron reflector – a layer of material (in this case beryllium, but it could also be natural or depleted uranium, iron or graphite, for example) that bounces back a significant share of generated neutrons – the critical mass of a given nuclear material is reduced. A 15 cm thick beryllium reflector reduces the critical mass of weapons grade uranium enriched to 93% U-235 by a factor of 4.5 from about 53 kg to less than 12 kg. That uranium mass would only have a diameter of less than 11 cm, a small cantaloupe. In the case of weapons grade plutonium with about 94% of the fissile isotopes Pu-239 + Pu-241 the critical mass is reduced by a factor of three from 11.5 kg to less than 4 kg with a diameter of hardly more than 7 cm, orange size.

In the case of a successful diversion, the detection of small quantities of fissile materials in transit constitutes a very major challenge. This is particularly difficult in the case of plutonium because it is essentially an emitter of alpha radiation that is not highly penetrating and can be shielded – and hidden – quite easily by a thin layer of material.

Could Sub-national Groups Design a Nuclear Weapon?

Today we see the use of home-made improvised explosive devices; tomorrow's threat may include the use of chemicals, bacteriological agents, radioactive materials and even nuclear technology.

Dame Eliza Manningham-Buller
Director General, The Security Service (MI5)
London, 9 November 06

We cannot exclude another mutation that would lead to chemical, biological, radiological or nuclear terrorism. (...) There is no doubt, moreover, that some of them have already thought about using such weapons and that they have envisaged to acquire them. Osama bin Laden has in fact often referred to Islam's need to endow itself with nuclear or chemical weapons. (...) Several terrorists arrested in France since 2001 had been involved with terrorist projects that included a rudimentary non-conventional aspect.

La France face au terrorism
White Book of the French Government
June 2006

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3 D.A.Dobson, D.N. Pipkorn, R.W.Selden, *The Nth Country Fission Weapon Design*, 14 December 1966
4 Dan Stober, op.cit.

In reality the question is less *whether* sub-national groups could build a nuclear explosive device, if they have access to a sufficient quantity of fissile material, than *under what conditions* and *how fast*. US Senator Joseph Biden, a member of the Senate National Security Working Group and co-chairman of the Senate Delegation to the NATO Parliamentary Assembly gave a chilling account of his own Nth Country Experiment:

> When I was chairman of the Foreign Relations Committee[5] […] I gathered the heads of all the national laboratories and some of their subordinates in [the Capitol]. I asked them a simple question. I said I would like you to go back to your laboratory and try to assume for a moment you are a relatively informed terrorist group with access to some nuclear scientists. Could you build, off-the-shelf, a nuclear device? Not a dirty bomb, but something that would start a nuclear reaction—an atomic bomb. Could you build one? They came back several months later and said: "We built one." I got together all of my colleagues and only a few showed up. Then I figured, well, they weren't paying much attention so I literally asked the laboratories to physically take this device into the Senate. Not a joke. As we used to say when I was a kid, it was bigger than a breadbox and smaller than a dump truck but they were able to get it in. They literally put it in a room and showed and explained how—literally off-the-shelf, without doing anything illegal—they actually constructed this device.[6]

While more difficult to build than the gun-type weapon, the Nth Country Experiment has demonstrated 40 years ago that it was feasible to design an implosion weapon with very limited means. Considering the immensely increased general technical and computing capabilities over the past decades, it seems obvious that even a sub-national group would be able to assemble such a device. Harvard scientists Bunn and Wier conclude:

> There is, in short, a very real possibility that a technically sophisticated terrorist group, given sufficient effort, could make a crude implosion-type bomb—particularly if they got knowledgeable help, as al Qaeda has been attempting to do. [Bunn, Wier 2006]

Porter Goss, Director of the CIA until May 2006, during a Congressional hearing in February 2005 on "Current and Projected National Security Threats to the US", puts it in similar words:

> It may be only a matter of time before al-Qa'ida or another group attempts to use chemical, biological, radiological or nuclear weapons.

Other scientists confirm the evaluation. Graham Allison, director of the Belfer Center for Science and International Affairs at Harvard's John F. Kennedy School of Government and author of *Nuclear Terrorism: The Ultimate Preventable Catastrophe,* concluded[7]:

> In sum, my best judgment is that based on current trends, a nuclear terrorist attack on the United States is more likely than not in the decade ahead. Developments in Iraq, Iran, and North Korea leave Americans more vulnerable to a nuclear 9/11 today than we were five years ago. Former Defense Secretary William Perry has said that he thinks that I underestimate the risk.

And Jay Davis, former head of the Pentagon's Defense Threat Reduction Agency during the Clinton administration, who also used to work as a U.N. inspector in Iraq, said there is general

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[5] Biden has been Chairman of the Senate Foreign Relations Committee in 1997 and after. There is no any more exact timing of the account.

[6] Keynote Speech to the Paul C. Warnke Conference on the Past, Present & Future of Arms Control, Georgetown University, 28 January 2004, see http://www.armscontrol.org/PDF/WarnkePDFTranscript.pdf

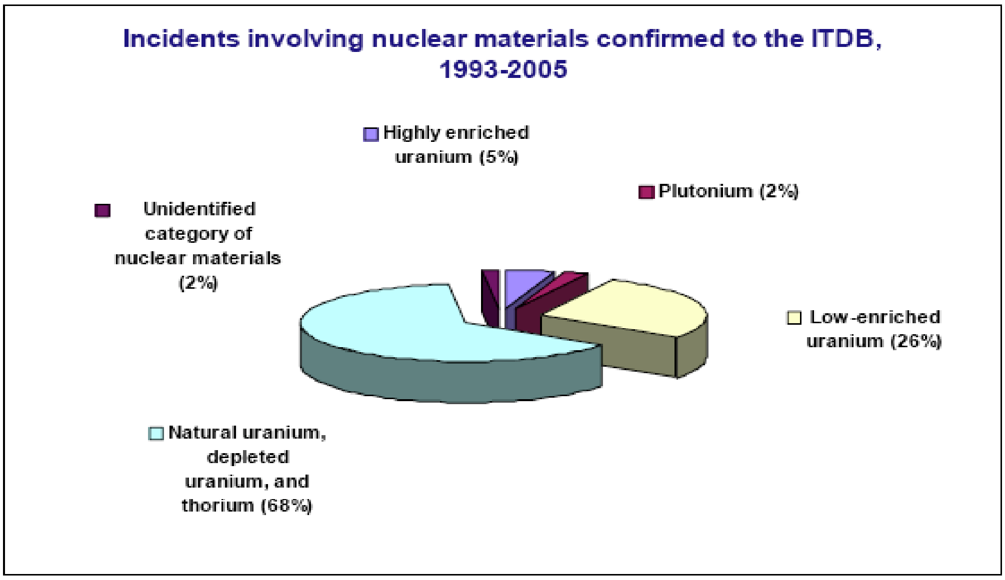
[7] Graham Allison, *The Ongoing Failure of Imagination,* Bulletin of the Atomic Scientist, September/October 2006

agreement in the nuclear community that terrorists can build a bomb. "A very small group of people could do that if they could get the material," he said.[8]

Access to Plutonium and Highly Enriched Uranium (HEU)

How likely it would be that states or sub-national groups "could get the material"? Between 1993 and 2005, the International Atomic Energy Agency's Illicit Trafficking Database has registered 827 confirmed incidents of which 224 incidents involved nuclear materials (see figure 4) and the rest mainly other radioactive materials. In 16 cases plutonium or high-enriched uranium was involved (see Figure 4). While most of the quantities seized were very small, a few cases involved kilogram quantities and all incidents demonstrate that there are sources for this kind of material and ways to extract it from facilities that should be perfectly secure.

Figure 4: Typology of 224 Identified Cases of Smuggled Nuclear Materials



Note: The total is higher than 100% because some incidents involved more than one category of nuclear materials.

Source: IAEA, Illicit Trafficking Database (ITDB), 2006

In addition, it is improbable that the detected cases constitute the entire number of incidents that took place. The US National Intelligence Council stated in its 2004 Annual Report to Congress on the Safety and Security of Russian Nuclear Facilities and Military Forces [NIC, 2004]:

> We find it highly unlikely that Russian authorities would have been able to recover all the material reportedly stolen. We assess that undetected smuggling has occurred, and we are concerned about the total amount of material that could have been diverted or stolen in the last 13 years.

CIA Director Porter Goss responds to a related question from a Congressman, with specific reference to Russia: "There is sufficient material unaccounted for, so that it would be possible for those with know-how to construct a nuclear weapon. I hope that's sufficiently clear."

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[8] Dan Stober, op.cit.

The official US 911 Commission considers it established that al Qaeda has attempted to obtain nuclear materials. It writes in its final report[9]:

> By 1997, officers in the [CIA] Bin Ladin unit recognized that Bin Ladin was more than just a financier. They learned that al Qaeda had a military committee that was planning operations against U.S. interests worldwide and was actively trying to obtain nuclear material. (…)
>
> Al Qaeda has tried to acquire or make nuclear weapons for at least ten years. (…)
>
> A nuclear bomb can be built with a relatively small amount of nuclear material. A trained nuclear engineer with an amount of highly enriched uranium or plutonium about the size of a grapefruit or an orange, together with commercially available material, could fashion a nuclear device that would fit in a van like the one Ramzi Yousef parked in the garage of the World Trade Center in 1993. Such a bomb would level Lower Manhattan.

George Tenet, Goss' predecessor as CIA Director, told the US Senate Select Committee on Intelligence in February 2004[10]:

> I have consistently warned this committee of al-QA`ida's interest in chemical, biological, radiological and nuclear weapons. Acquiring these remains a "religious obligation" in Bin Ladin's eyes, and al-QA`ida and more than two dozen other terrorist groups are pursuing CBRN [Chemical, Biological, Radiological, Nuclear] materials. (...)
>
> Al-QA`ida continues to pursue its strategic goal of obtaining a nuclear capability. It remains interested in dirty bombs. Terrorist documents contain accurate views of how such weapons would be used.

Nuclear Materials on a Tray – Plutonium on the Road

Some countries continue to pursue a nuclear policy that combines two major security problems: the accumulation of large toxic and strategic inventories and research or industrial activities that render strategic materials very vulnerable. While there is a long list of technologies and materials that are relevant for the implementation of a complete nuclear weapon system, the key ingredients of a nuclear explosive device remains either high-enriched uranium or plutonium. There are only few countries that use plutonium on a commercial scale.

Figure 5: Plutonium Shipment in France - *Easy to Approach*

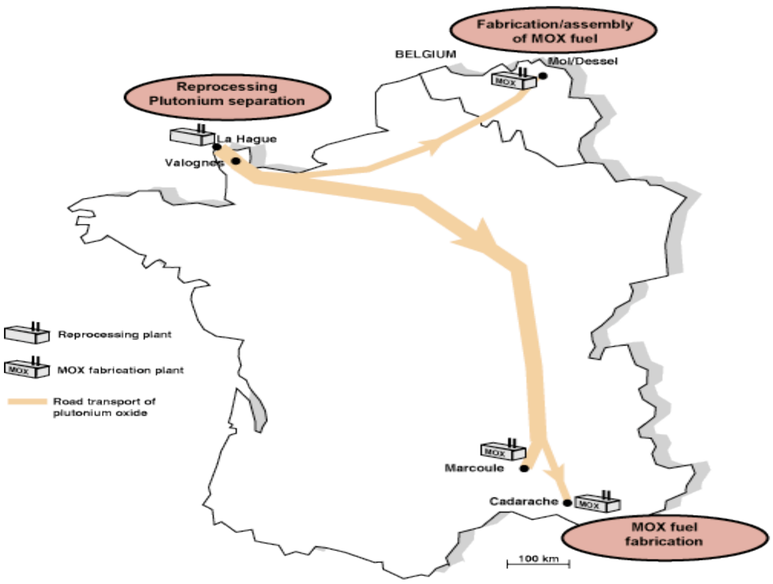
Photo: Greenpeace

[9] The 9/11 Commission Report, *Final Report of the National Commission on Terrorist Attacks Upon the United States*, undated. http://www.gpoaccess.gov/911/pdf/fullreport.pdf

[10] George J. Tenet, *The Worldwide Threat 2004: Challenges in a Changing Global Context*, Testimony of Director of Central Intelligence before the Senate Select Committee on Intelligence, CIA, 24 February 2004 ; https://www.cia.gov/cia/public_affairs/speeches/2004/dci_speech_02142004.html

France is the only nuclear country that separates large quantities of plutonium, at its La Hague reprocessing plants, produces significant amounts of plutonium bearing MOX (uranium-plutonium mixed oxide) fuels, at its Marcoule based MELOX plant, and operates a significant number of commercial reactors (up to 20) with MOX fuel. Numbers and distances of inherently necessary shipments involving unirradiated plutonium, either in separated form (oxide powder) or in the form of fresh MOX fuel are staggering (See figures 6 and 7). In a detailed report WISE-Paris analysts have illustrated the scope of the movements.[11] In order to fuel the system, 90 shipments of up to 150 kg of separated plutonium each role over French streets, on average about twice a week year round every year, and accumulate very long travel distances and times. Annually, given the distances between the plants (>800 km between the plutonium factory at La Hague and the MOX fabrication plant at Marcoule), transport of separated plutonium oxide powder accounts for over 8,000 ton-plutonium-km. One has to add the unirradiated MOX movements that contain around 250 kg of plutonium per shipment.[12]

Figure 6 Transport of plutonium oxide powder in France (shipments to the Cadarache plant have ceased in 2003 after the termination of commercial fuel fabrication at the plant; shipments to the Belgian Dessel plant have ceased in 2006 following the definitive closure of the facility)



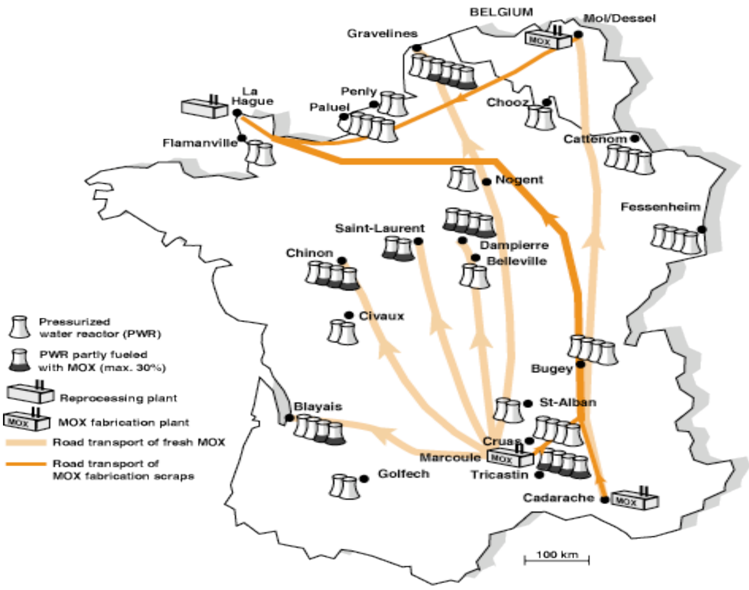
Source: WISE-Paris, 2002

The environmental group Greenpeace has demonstrated how easy it is to identify routes and travel schedules and to physically access the plutonium trucks. On 19 February 2003 a group of 25 activists blocked a shipment close to Chalon-sur-Saône and chained themselves to the vehicle.

[11] MARIGNAC Yves (Director of the Project), COEYTAUX Xavier, FAÏD Yacine B., HAZEMANN Julie, SCHNEIDER Mycle, *Les transports de l'industrie du plutonium en France. Une activité à hauts risques*, commissioned by Greenpeace France, WISE-Paris (Ed.), Paris, February 2003

[12] English summary of the WISE-Paris report, see http://www.wise-paris.org/english/reports/030219TransPuMAJ-Summary.pdf (for details on figures see Annex 3)

Figure 7 Transport of unirradiated MOX fuel in France (following the closure of the MOX fabrication plants in Cadarache in 2003 and in Dessel in 2006, all of the MOX shipments leave from the MELOX facility in Marcoule)



Source: WISE-Paris, 2002

One has to add to the shipments of separated plutonium the transport of fresh MOX fuel from the manufacturing plant to the nuclear power plants in France (see figure 7), Belgium, Germany, Sweden and Switzerland, which also contributes a substantial proliferation risk, because the plutonium can be separated from the fuel by straightforward chemical means. Since the French AREVA NC and the British BNFL also have Japanese customers, MOX fuels are also transported by ship from Europe to Japan. In the past, several shipments of up to over one ton of separated plutonium have also been carried out.

All of these shipments of unirradiated, separated plutonium and plutonium bearing materials constitute a potential target for sub-national groups and states.

Highly Enriched Uranium (HEU) for Research Reactors

Highly enriched uranium (HEU), containing >20% of fissile U-235, is used only in nuclear weapons and in research reactors. While until the end of the 1970s a large number of research reactors used HEU fuels, since 1978, there is only one single new reactor that has been built that operates with HEU fuel and that is the German FRM-2.[13] By the late 1970s it was recognised that the spread of HEU around the world to over one hundred reactor sites in many countries significantly added to the proliferation risk. Under the leadership of the American Argonne National Laboratory (ANL), in 1978, the Reduced Enrichment for Research and Test Reactors (RERTR) Program was set up. It develops technology necessary to enable the conversion of civilian facilities using HEU to low enriched uranium (LEU) fuels and targets. Over 40 research reactors around the world have since been converted to LEU. However, over 60 reactors still operate on HEU and a total of 105 are to be converted to LEU by 2013. Each fuel shipment to and from the reactor constitutes a proliferation risk.

[13] http://www.world-nuclear.org/info/inf61.htm

Theft of Nuclear Materials by States

There are several cases in history where a state (Israel) has actually hijacked shipments of nuclear material. In 1968 Israel diverted a shipment of 200 tons of uranium ore on the high seas. The event is known as the Plumbat Affair. However, as former Nuclear Regulatory Commissioner (NRC) Victor Gilinsky points out, there was a less publicised event in 1968 that was "revealed" during a briefing by CIA Deputy Director Carl Ducket only in 1976:

> But there is more. [...] The reason Duckett briefed a small group of commissioners (of whom I was one) and several senior NRC staff was not to tell us Israel had the bomb. It was rather to deal with rumors about a deeper secret in the CIA reports, one that had an even bigger potential for political disaster, and one that I believe was the real reason for the hyper-secrecy. What Duckett confirmed, to everyone's astonishment, was that the CIA believed that the nuclear explosives in Israel's first several bombs, about one hundred kilograms of bomb-grade uranium in all, came from material that was missing at a US naval nuclear fuel plant operated by the Nuclear Materials and Equipment Corporation (NUMEC), in Apollo, Pennsylvania.[14]

One year after the Plumbat and NUMEC affairs, in 1969, the German company Asmara-Chemie buys 324 kg of natural uranium concentrate from the uranium broker NUKEM and brings it out of the country without informing neither EURATOM nor the IAEA. The EURATOM safeguards people discovered the plot. The Asmara manager was put under considerable pressure by German authorities and he managed – nobody knows how (at least nothing was ever published) – to recover the material. The original destination was apparently Argentina, a country with well-known weapons ambitions at the time.

Several countries have used illegal trafficking means to acquire equipment and materials in the past. In the 1980s Pakistan, for example, had established a complex network of suppliers that worked out of the Paris Embassy and delivered entire facilities in dozens of truckloads. A number of French and German companies played a key role in the trafficking[15]. In 2004 Islamabad admitted that Abdul Qadeer Khan, considered the "father" of Pakistan's nuclear program had established a network that in turn literally distributed nuclear weapons related technology to various countries, including Iran, Libya and North Korea.

There is absolutely no reason to exclude any move by a state to buy, hijack, steal, rob or divert nuclear materials and technology in the future, especially when it comes to the strategic bomb materials highly enriched uranium and plutonium.

Theft of Nuclear Weapons

In addition to the potential acquisition of nuclear materials, there is the potential of transmission or theft of entire nuclear warheads. While most modern weapons have highly sophisticated protective systems (Permissive Action Links or others) that prevent an unauthorised person to set off a nuclear weapon, most of the older type weapons do not have the same kind of security device. This is especially the case for pre-1980 Russian tactical nuclear weapons. There is evidence of keen interest by sub-national groups in nuclear weapons.

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[14] Victor Gilinsky, *Israel's Bomb,* New York Times, 14 May 2004, http://www.nybooks.com/articles/17104

[15] for details see Mycle Schneider, *Nucléaire: Paris, plaque tournante du trafic pakistanais,* Politis 1989

The US National Intelligence Council stated [NIC 2004]:

> Russian officials have reported that terrorists have targeted Russian nuclear weapons storage sites. Security was tightened in 2001, after Russian authorities twice thwarted terrorist efforts to reconnoiter nuclear weapon storage sites.

Even if it turned out impossible for a sub-national group to detonate a stolen nuclear device, the mere fact of a nuclear weapon having gone missing would allow terrorist organisations or even states to deliver a credible threat. Should a stolen weapon turn out to be impossible to be detonated by an unauthorised person, the weapon might also contain enough fissile material to take it apart and build a crude nuclear device of different design.

Proliferation- or Non-Proliferation Treaty?

> The rather disappointing record of the 1968 Treaty on the Non-Proliferation of Nuclear Weapons (NPT) raises the question of whether the global governance of nuclear weapons can work without first ensuring their democratic governance at the national level.
>
> SIPRI Yearbook 2006

The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) was signed in 1968 and entered into force on 5 March 1970. Depositary Governments were the UK, the US and the USSR. Including North Korea that withdrew from the agreement on 10 January 2003, the treaty has been signed since by 188 countries. The NPT was and is considered a political bargain between the Nuclear Weapon States (NWS) and the Non-Nuclear Weapon States (NNWS), between the have and the have not states. The treaty text is a straightforward 5-page document containing 11 articles of surprising clarity.

Under **Article I** the signatory NWS undertake not transfer any nuclear explosive device or control over them to any NNWS and not to assist in the development or control over such a device. Under **Article II** the NNWS promise not to seek any nuclear weapons or control over them.

There are numerous examples with strong indications for more or less clear violations of letter and/or spirit of Art. I and II by NWS and NNWS. Both, the have and have not states, especially prior to their NPT signature but also after, have massively transferred nuclear know-how, materials and equipment to countries that were, openly or clandestinely, pursuing nuclear weapons programs. In some cases NWS have based nuclear weapons in NNWS and provided training on the delivery of those arms. The following are merely a few examples[16]:

• The **United States**

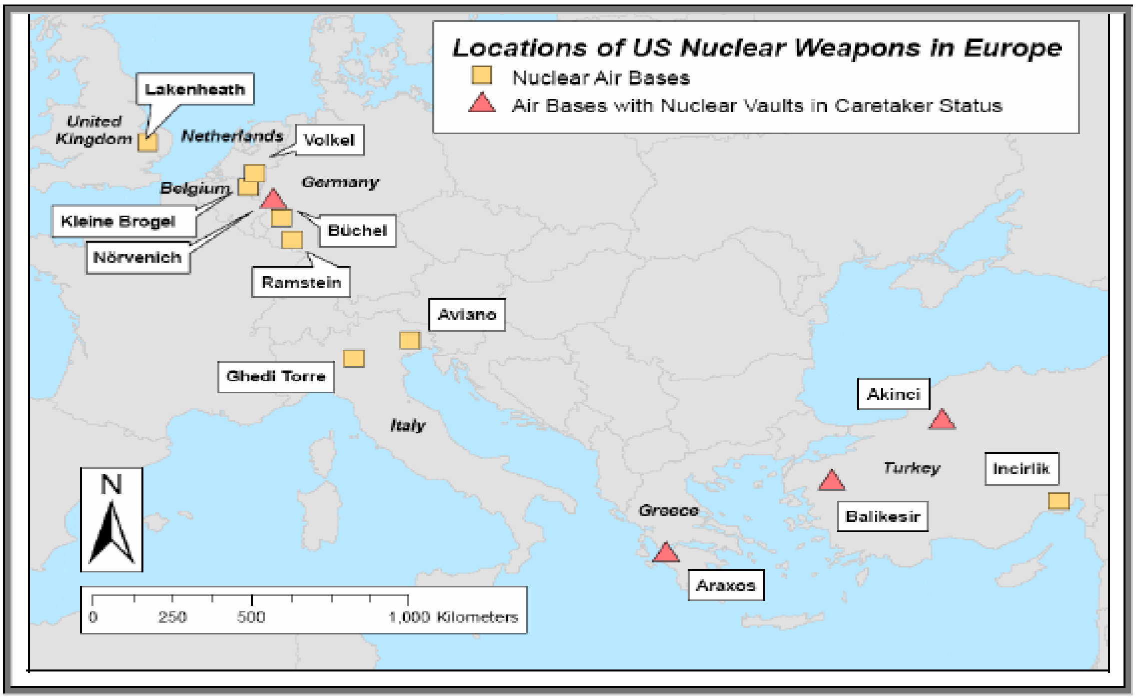
- exported small quantities of uranium and plutonium and a 5 MW research reactor to Iran that went critical in 1967;
- until today, deploys nuclear weapons in European NNWS (Belgium, Germany, Italy, Netherlands, Turkey, see figure 8) and maintains nuclear bombing ranges in these countries; the current nuclear force level in Europe, about 480 nuclear weapons, is two to three times larger than in the 1990s (greater than the entire Chinese stockpile)[17];

[16] if not otherwise specified, the information is based on country profiles of the NTI at nti.org.

[17] for details see the stunning report by Hans M. Kristensen, *US Nuclear Weapons in Europe*, NRDC, 2005

- trains European pilots to deliver US nuclear weapons; nuclear cooperation agreements exist with Belgium, Germany, Italy, the Netherlands, and Turkey to enable their national air forces to deliver U.S. nuclear bombs in times of war[18] ;

Figure 8: **US Nuclear Weapons in Europe in 2005**



• **Russia** picked up the nuclear cooperation with Iran on the construction of the Bushehr nuclear power plant left by the Germans in 1979 and transmitted not only know-how but also parts for other facilities, including centrifuge parts for uranium enrichment (in 2001).

• **France** signed the NPT only in 1992. There is a long list of proliferating actions France has taken prior to its NPT signature, including:

- the supply to Israel of the Dimona reactor that has generated the plutonium for Israel's nuclear weapons;
- the supply to Iraq of the Osirak reactor;
- the signature with Pakistan over the supply of a reprocessing plant, a deal that was not carried through only due to intensive US pressure.

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[18] Kristensen comments: "The United States insists that no transfer of the nuclear bombs or control over them is intended 'unless and until a decision were made to go to war, at which the [NPT] treaty would no longer be controlling.' Therefore, the United States agues, there is no breach of the NPT. But the nuclear mission is not dormant until a decision has been made to go to war, and there is no provision that the near-universal treaty expires if one or a few of its signatory states decide to go to war. Even in peacetime, the fighter-bomber pilots of the "non-nuclear" NATO nations practice and prepare for handling and delivering the U.S. nuclear bombs. Besides, the strictly legal argument misses the point. Such peacetime operations certainly contravene both the objective and the spirit of the NPT. It endorses the concept that non-nuclear countries may adopt "surrogate" nuclear roles on behalf of nuclear powers. If China deployed nuclear weapons at North Korean air bases, equipped North Korean fighter jets with the capability to carry nuclear weapons, and trained North Korean pilots to design nuclear strike missions and deliver the weapons against targets in South Korea and Japan, the United States and NATO would raise hell – and rightly so." [Kristensen 2005]

• **China**, according to the US, assisted Pakistan's weapon program by providing nuclear-related materials, scientific expertise, and technical assistance and also

- an unspecified number of calutrons that can be used for uranium enrichment to Iran (1989);
- research reactor, uranium enrichment equipment, 1 ton of uranium hexafluoride (UF6) and 800 kg of UF4 to Iran (1991)
-

International Nuclear Assistance to India – *Just an example*

India profited of significant foreign nuclear assistance before and after it had exploded a nuclear device in 1974. Even after the test series of five nuclear weapons in May 1998, many countries continued to deliver hard ware and know how to India, a non-signatory of the NPT:

• **Canada** has supplied the Cirus reactor and nuclear fuel to India that generated plutonium for its weapons program. Further Canadian technology CANDU reactors also were used for weapons plutonium production. The Canadian government granted earmarked loans for nuclear projects.

• The **United States**

- prior to NPT signature has trained Indian nuclear scientists and engineers, provided heavy water[19] for the Indian Cirus weapon plutonium production reactor, sold the blue prints for plutonium separation, provided two commercial boiling water reactors and earmarked loans, small amounts of plutonium "for research purposes";

- after the entry into force of the NPT in 1970 and India's first nuclear weapon test in 1974, provided low enriched uranium (1978-1980), a Cray Supercomputer (1990);

- after the second nuclear test series in 1998 signed a far reaching controversial cooperation agreement in 2005.

• **France** provided technical assistance to India for design and construction of a heavy water plant and a fast breeder test reactor; in 2006 signed a far-reaching declaration on nuclear cooperation covering basically all aspects of nuclear technology, including transfer of materials and technology.[20]

• The **Soviet Union/Russia** supplied large quantities of heavy water (1980) and low enriched uranium (2001)

• **China** exported low enriched uranium (1995)

• **Germany** exported beryllium, a nuclear weapon ingredient (1989).

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[19] heavy water is the indispensable moderator of heavy water reactors

[20] see http://www.diplomatie.gouv.fr/en/country-files_156/india_500/visits_3264/declaration-by-france-and-india-on-the-development-of-nuclear-energy-for-peaceful-purposes-bangkok-february-18-2006_3910.html

Nuclear Safeguards

Safeguards is probably the most difficult task entrusted to an international organization. (...) we are probably the only organization that sits in judgment of its Member States. And that´s not easy of course because the Member States are our subjects and they are our masters at the same time.

Mohamed ElBaradei
Director General of the IAEA

Art. III of the NPT calls for the negotiation of comprehensive safeguards agreements with the International Atomic Energy Agency (IAEA). Safeguards agreements are in force in 156 states, including 148 NNWS, voluntary offer safeguards in the five NPT nuclear weapon states (US, UK, Russia, France, China) and item specific safeguards in three non-NPT states (India, Israel, Pakistan). About 900 facilities in some 70 countries are officially under IAEA safeguards - a monstrous task, especially considering the extremely limited resources.

In 2005 the IAEA had a total budget for safeguards of less than $ 136 million (about € 107 million), including regular budget and extra-budgetary resources[21]. This is about a third of the amount that the French nuclear builder AREVA NP has provisioned in 2006 for losses linked to a projected one-year delay in the construction of one single nuclear power plant[22]. The IAEA Director General and his Deputy and Head of Safeguards like to compare the financial capacities of his organisation, supposed to verify nuclear activities in the whole world, with the budget of the Vienna police department.

> It is instructive to view the Agency's safeguards budget in relative terms. A total safeguards budget of just over 100 million dollars per year for an international inspectorate might be compared with the 300 million dollars allocated annually to the Vienna Police Department. The cost of the Gulf War of 1991, was equivalent, in 3 months time, to some 1,000 years of the Agency's regular budget for Safeguards.[23]

The technical efficiency and reliability of IAEA safeguards is limited. The NPT is a political treaty and the safeguards are very much seen as a confidence building measure. Even if it must be stressed that the rights of IAEA inspectors are amongst the most intrusive in international right. But the safeguards goals are in general modest and the probability of the diversion of nuclear material or the development of a clandestine weapons program remaining undiscovered stays high. The IAEA did not discover for years clandestine activities in Iraq, Iran, Libya and North Korea, for example, and it is still investigating the vast illegal network built up by the Pakistani Chief weapon scientist Abdul Qadeer Khan.

In order to have the access to facilities, documents and people the Agency needs, the countries have to sign and enforce the Additional Protocol to the Safeguards Agreement. A Model Additional Protocol has been approved by the IAEA Board of Governors in 1997, "in order to strengthen the effectiveness and improve the efficiency of the safeguards system as a contribution to global nuclear non-proliferation objectives".[24] However, nine years after its introduction only 78 countries out of over 180 that are party to the NPT have an Additional

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[21] IAEA, *Annual Report 2005*
[22] the Siemens-Framatome EPR (European Pressurised Water Reactor) project in Olkiluoto in Finland
[23] Pierre Goldschmidt, *Present Status and Future of International Safeguards,* JNC International Forum for Peaceful Utilization of Nuclear Energy, 12 February 2003
[24] IAEA, *Model Protocol Additional to the Agreement(s) Between State(s) and the International Atomic Energy Agency For the Application of Safeguards*, INFCIRC 540, September 1997

Protocol in force.[25] "Without the protocol", Mohamed ElBaradei states, "we are hampered on our ability to detect undeclared activities."[26] The protocol with the EU countries and EURATOM only entered into force on 30 April 2004.[27] States that lack enforcement of the Additional Protocol include Iran, Kazakhstan, Mexico, Russia and the USA.

Safeguards in the EU

In 2003[28], the European Commission spent € 13 million on nuclear safeguards (equivalent to about half the annual budget of the international lobby organisation Nuclear Energy Institute or some 2% of the annual budget for nuclear research under the 7th EU Framework Programme). Almost half of the expenditure covered "investments made in large scale plutonium bulk handling plants[29] and related maintenance, operation and logistics".[30] However, while the amount of plutonium under safeguards in the EU has practically tripled since 1990 to reach about 600 tons, the number of inspection days has decreased steadily (by 27% between 1999 and 2003, see table 1). The Commission claims the latest decreases "mainly resulted from further streamlining and prioritisation of inspection activities".[31] Unresolved technical and accountancy problems remain. These include higher than expected MUF (material unaccounted for), higher than expected differences in "shipper-receiver" declarations involving plutonium as well as inspector site access refusals and delays due to operators that contested identification documents.

Table 1: Inspection Activities of EURATOM Safeguards – Steady Decline

Person days of inspection in:	1999	2000	2001	2002	2003
Non-Nuclear Weapon States	2412	2113	2328	2348	1990
France	3492	3426	2934	2539	2266
UK	2871	2895	2399	2404	2110
Total	8775	8434	7661	7291	6366

Source: European Commission

[25] for an updated list of the status on Additional Protocols see http://www.iaea.org/OurWork/SV/Safeguards/sg_protocol.html

[26] Mohamed ElBaradei, *Addressing Verification Challenges*, Speech delivered at the Symposium on International Safeguards, Vienna, 16 October 2006

[27] The entry into force date is defined as „the date on which the Agency received written notification that the European Atomic Energy Community and the signatory States of the Additional Protocol had met their respective requirements for entry into force », see IAEA, INFCIRC/193/Add.8, 12 January 2005

[28] No more recent data has been published by the Commission.

[29] the reprocessing plants at La Hague (FR) and Sellafield (UK) and the MOX fuel fabrication facilities at Marcoule (FR), Cadarache (FR) and Dessel (BE)

[30] European Commission, *Euratom Safety and Security – Activities in 2003,* Communication from the Commission to the European Parliament and the Council, COM(2004)861 final, Brussels, 7 January 2005

[31] ibidem

Art. IV of the NPT should guarantee global access to nuclear technology to any signatory country. It is the article Iran keeps pointing to since it proclaims "the inalienable right of all the Parties to the Treaty to develop research, production and use of nuclear energy for peaceful purposes without discrimination". The article goes even further: "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."

The NPT actually guarantees access to the full range of nuclear technologies, including to the parts of the system that mostly threaten the non-proliferation regime, which are uranium enrichment and reprocessing. And the IAEA is to serve not only as the controller but also as the technology broker under the NPT. The vast majority of its annual budget is spent under its obligations to spread nuclear technology around the world and knowledge around the world.

Its mission statement stipulates that the IAEA, on one hand:

> serves as the global focal point for nuclear cooperation; assists its Member States, in the context of social and economic goals, in planning for and using nuclear science and technology for various peaceful purposes, including the generation of electricity, and facilitates the transfer of such technology and knowledge in a sustainable manner to developing Member States.

… and on the other hand:

> verifies through its inspection system that States comply with their commitments, under the Non-Proliferation Treaty and other non-proliferation agreements, to use nuclear material and facilities only for peaceful purposes.

The IAEA has to promote nuclear technology and to verify its use at the same time. In other words, the Agency's left hand is supposed to control what it gives out with its right hand. A problematic task.

Art. VI of the NPT defines the obligations of the Nuclear Weapons States parties to the treaty. It states:

> Each of the Parties to the Treaty undertakes 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 Nuclear Weapon States have violated Art. VI ever since the NPT has been signed. In 1970, at the time the NPT came into force, the five NPT nuclear weapon states owned an estimated 38,700 warheads. Since then the number of atomic bombs grew steadily to over 70,000 in 1986. A year later, the U.S. and the Soviet Union signed the Intermediate-Range Nuclear Forces Treaty to eliminate all intermediate- and short-range land-based nuclear missiles. The treaty entered into force on 1 June 1988, but the first US Pershing weapon has been destroyed only seven years later.

The first Strategic Arms Reduction Treaty (START-I) between the U.S. and Russia, cutting their long-range nuclear forces from a Cold War high of between 11,000 and 12,000 warheads to between 6,000 and 7,000 for each side, entered into force on 5 December 1994. Six months later the NPT is extended indefinitely. US President Clinton signs the Comprehensive Test Ban Treaty (CTBT) in September 1996 followed by representatives of the four other official NPT nuclear weapon states.

START-II was signed in 1993. Each side committed to limit the total number of strategic warheads to 3,000-3,500. None may be on multiple warheads of intercontinental ballistic missiles, which shall only carry a single warhead each. However, 1,700-1,750 warheads, which can be multiple warheads, could still have been deployed on submarines. The START-II limitations and reductions should have been completed by 31 December 2007 rather than 2004, a new deadline as provided for in an extension protocol signed in 1997.

The United States ratified the original START-II agreement in January 1996, but never ratified the 1997 extension protocol. On 4 May 2000 Russian President Vladimir Putin signed the resolution of ratification for START-II, its extension protocol and the 1997 ABM-related agreements. Russia's ratification legislation made exchange of START-II's instruments of ratification (required to bring it into force) contingent on U.S. approval of the extension protocol and the Anti-Ballistic Missile (ABM) agreements. The US Congress never ratified the entire package.

One day after the United States withdrew from the ABM Treaty in June 2002, Russia announced that it would no longer be bound by its START-II commitments. Moscow's statement came a few weeks after the two countries had concluded a new nuclear arms agreement, the Strategic Offensive Reductions Treaty (SORT), which requires the United States and Russia to reduce their deployed strategic arsenals to 1,700-2,200 warheads the end of 2012 and effectively superseded START-II's requirements. Yet other key START-II provisions, such as the prohibition against deploying multiple warheads on intercontinental ballistic missiles, were not addressed at all in the SORT agreement.

The dismantling of nuclear weapons in Russia and especially in the US has considerably slowed down over the last ten years (see graph 9a) and it remains highly uncertain whether the SORT targets will be reached.

The presence of some 26,000 nuclear weapons in the US and Russia alone 36 years after the entry into force of the NPT has significantly undermined the credibility of the treaty. In addition, the nuclear weapon states have continued and continue to develop new nuclear weapons. Over the past five years, on the basis of its *Nuclear Posture Review (NPR)*[32] the US government has reactivated research and development programs that aim to design new generations of nuclear weapons. A specific program was to look into the development of nuclear “bunker buster” weapons capable to destroy targets deep underground, but it did not get the green light in Congress.

The US National Nuclear Security Administration (NNSA) has secured funding for fiscal years 2006-07 of about $ 25 million each for a program called Reliable Replacement Warhead (RRW). The NNSA assures that “RRW is not a new weapon providing new or different military capabilities and/or missions. It will meet the same military requirements as current legacy warheads by utilizing replacement components.”[33] However, there are suspicions that RRW is merely another name for an entirely new generation of nuclear weapons.
The RRW design is to be chosen before the end of 2006. If government and Congress give the go ahead, the next step would be the engineering development phase that is expected to take about five years.

[32] declassified excerpts at http://www.globalsecurity.org/wmd/library/policy/dod/npr.htm
[33] NNSA, *NNSA's Reliable Replacement Warhead (RRW) Program,* NNSA – Factsheet, May 2006

Figures 9 a)-c) Nuclear Weapons Stockpiles in the World 1945-2006

Figure 9 a) Nuclear Weapons in the USA and in Russia 1945-2006

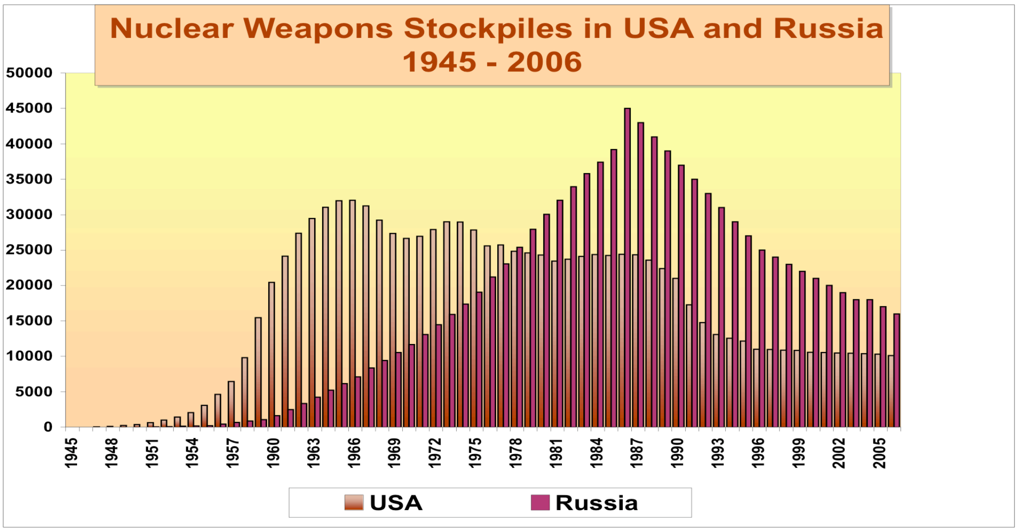


Figure 9 b) Nuclear Weapons in the UK, France and China 1945-2006

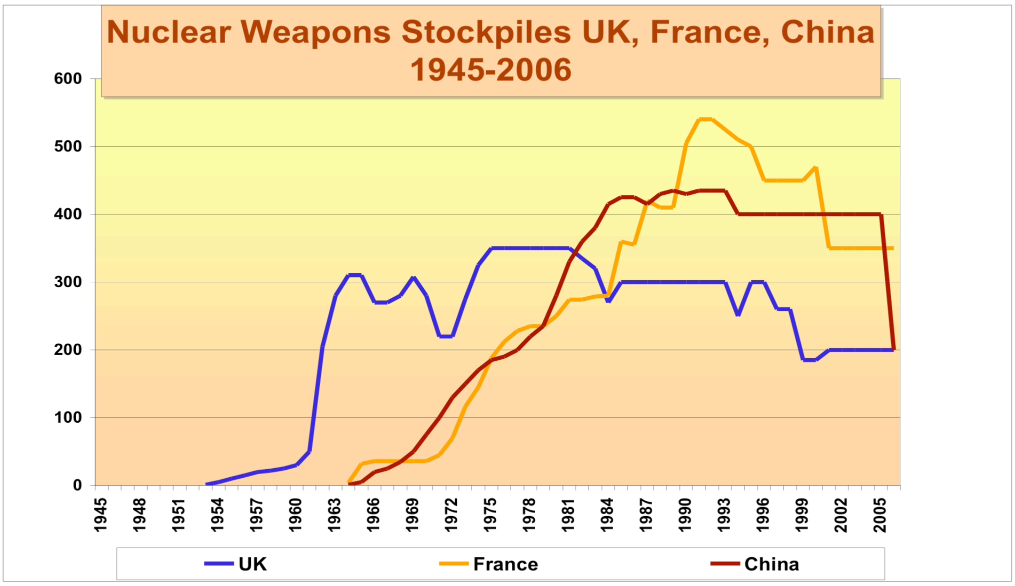
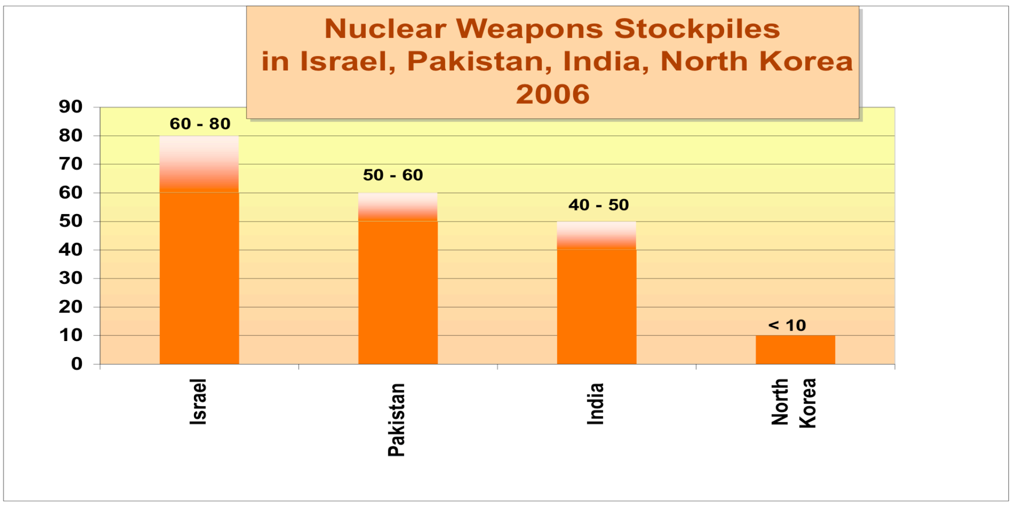


Figure 9 c) Nuclear Weapons in Israel, Pakistan, India and North Korea in 2006



Art. X of the NPT provides for the withdrawal from the treaty in simple terms:

> Each Party shall in exercising its national sovereignty have the right to withdraw from the Treaty if it decides that extraordinary events, related to the subject matter of this Treaty, have jeopardized the supreme interests of its country. It shall give notice of such withdrawal to all other Parties to the Treaty and to the United Nations Security Council three months in advance. Such notice shall include a statement of the extraordinary events it regards as having jeopardized its supreme interests.

North Korea is the only country ever to have made use of Art. X when it announced its withdrawal from the treaty in 2003.

The North Korea Case

North Korea's withdrawal from the NPT on 10 January 2003 terminated a 10-year long story of front- and back-stage negotiations to get the country off the nuclear weapons path. The Democratic People's Republic of Korea (DPRK) or North Korea became a member of the NPT in 1985. After the withdrawal of US nuclear weapons from South Korea, on 20 January 1992 South and North Korea signed a joint declaration (entered into force on 19 February 1992) where both countries agreed "not to test, manufacture, produce, receive, possess, store, deploy, or use nuclear weapons; to use nuclear energy solely for peaceful purposes; and not to possess facilities for nuclear reprocessing and uranium enrichment".[34] On 10 April 1992 entered into force the safeguards agreement with the IAEA, signed in January 1992. After a series of inspections, in early 1993 the IAEA was denied access to certain waste sites and on 12 March 1993 North Korea announced its intention to withdraw from the NPT.[35] According to Art. X of the treaty withdrawal is not effective until three months later. Following frenzy negotiations with the Clinton administration North Korea announced the suspension of the withdrawal from the NPT one day before it was to become effective. It agreed to implement the safeguards agreement, but only for present and not past activities. The Additional Protocol was never signed.

In October 1994 the basis for the *Agreed Framework* had been negotiated between the US and North Korea. Under the deal North Korea would receive two light water reactors to be delivered turn-key by the South Korean company KEPCO and operational by 2003 and would in turn freeze its domestic gas-graphite reactor and reprocessing programs. North Korea would also receive 500,000 tons of heavy fuel oil per year until the first reactor would go online. In March 1995 the Korean Economic Development Organisation (KEDO) was set up to implement the key provisions of the Agreed Framework. Initial KEDO members were Japan, South Korea and the US. Later joined the EU[36], Argentina, Australia, Canada, Chile, Czech Republic, Indonesia, New Zealand, Poland and Uzbekistan. The Supply Agreement between KEDO and the North Korean government was signed on 15 December 1995. According to the agreement, KEDO should "develop a delivery schedule for the LWR project aimed at achieving a completion date of 2003."

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[34] *Joint Declaration of South and North Korea on the Denuclearization of the Korean Peninsula,* Inventory of International Nonproliferation Organizations and Regimes, Center for Nonproliferation Studies, 2002

[35] Nuclear Threat Initiative, *North Korea Profile*, http://www.nti.org/e_research/profiles/NK/Nuclear/index.html

[36] on 19 September 1997

The reactor project took significantly longer than projected. The first concrete was poured for the main power plant buildings at the Kumho site only in August 2002. In November 2002 KEDO suspended the fuel oil deliveries to North Korea. At the moment when the reactor work was suspended on 1 December 2003, there was not much more done than the first concrete on the first unit.[37]

Figure 10: The Kumho Nuclear Power Plant Site in North Korea

Source: KEDO

What happened in October 2002 that led to the abrupt decision by North Korea to withdraw from the NPT? Here is how the events have been written up by the US Congressional Research Service (CRS)[38]:

> Scheduled bilateral talks were postponed in summer 2002 due to a naval skirmish between the North and South Koreans; during this delay, U.S. intelligence, building on evidence dating back to 1998, reportedly indicated that the North Koreans were secretly developing a highly enriched uranium program. Prospects for successful talks were derailed when Assistant Secretary of State James Kelly reportedly presented the North Koreans with evidence of the program during a visit to Pyongyang in October 2002. North Korea reportedly confirmed the allegations. The Bush Administration maintained that the suspected uranium program constituted a breach of Pyongyang's international obligations under the 1994 Agreed Framework and the Nuclear Non-proliferation Treaty (NPT).

The CRS account remarkably contains three times the term "reportedly". In fact, to date no evidence has been presented by the US government to support the "reported" information. The North Korean government on several occasions denied having recognised or confirmed anything. The official North Korean (DPRK) Central News Agency on 25 October 2002, calling for a US-North Korean Non-Aggression Treaty, stated:

> It was against this backdrop that the DPRK recently received a special envoy of the U.S. President in the hope that this might help fundamentally solve the hostile relations with the U.S. and settle outstanding issues on an equal footing. (…)
>
> Producing no evidence, he asserted that the DPRK has been actively engaged in the enriched uranium program in pursuit of possessing nuclear weapons in violation of the DPRK-U.S. agreed framework.

It seems indeed puzzling that North Korean officials first should have "confirmed" the existence of a clandestine uranium enrichment program and denied everything after. Unless

[37] see photographs of the site at http://kedo.org/lwr_ci_cs_results.asp

[38] Mark E. Manyin et al., *North Korea: A Chronology of Events, October 2002 – December 2004,* CRS Report for Congress, 24 January 2005

the US government provides the international community with the alleged evidence, it cannot be excluded that the entire developments leading to the North Korean nuclear test in October 2006 were actually triggered or at least boosted by US manipulated information.

It is also remarkable to note that South Korea, until the nuclear test, actually continued its *Sunshine Policy* aiming at reunification. Also, the EU and Italy in particular, had continued to maintain some diplomatic activities. At the end of October 2006, the situation seemed frozen, as even North Korea's most important allies South Korea and China had given up to hold back with public criticism of the North Korean nuclear course. But in December 2006, the approach through the six-party talks[39] seemed to have gotten back on track and on 13 February 2007 a "North Korea - Denuclearization Action Plan" was signed in Beijing. The first point of plan stipulates:

> The DPRK will shut down and seal for the purpose of eventual abandonment the Yongbyon nuclear facility, including the reprocessing facility and invite back IAEA personnel to conduct all necessary monitoring and verifications as agreed between IAEA and the DPRK.[40]

It is only in February 2007 that some voices start to publicly question the reality of the US allegations. David Albright, President of the Institut for Science and International Security (ISIS) and former IAEA inspector for Iraq, states:

> „The supposed admission by North Korean officials in late 2002 about a centrifuge program may have been oversold by U.S. officials. (...) *USA Today* on November 4, 2004 quoted a U.S. intelligence official that the CIA is "not certain there even is" a uranium enrichment plant. (…) In the last few years, firm evidence to support the existence or schedule of the construction of a large scale centrifuge has not emerged. (...) One senior U.S. official knowledgeable about the intelligence on North Korea's nuclear program said in January 2007 that there has not been evidence in the last few years of procurements for a large-scale North Korean centrifuge program. (...)
> Policy towards North Korea that does not reflect the reality of its nuclear programs could lead to further missed opportunities and the squandering of recent progress. It was the claim of the existence of a large program that brought down the 1994 Agreed Framework in the fall of 2002 and poisoned many cooperative initiatives between North Korea and its neighbors.[41]

The IAEA's Director General visited North Korea 13-14 March 2007, a trip he considered an "overall door opener". Mohamed ElBaradei stated that North Korea "was very clear they are ready to implement the February 13 agreement once the other parties implement their part of the deal."[42] In the short term, the other part of the deal is the delivery of 50,000 tons of fuel oil to start with.

This sounds like a surprising and promising turn of events. Christopher R. Hill, Assistant Secretary for East Asian and Pacific Affairs, declared after the signature:

> I don't work on Iran, but I will tell you that denuclearization is the way to go, that weapons of mass destruction do nothing for these countries. I

[39] The six parties are China, North and South Korea, Japan, Russia and the USA.
[40] http://www.fmprc.gov.cn/eng/zxxx/t297463.htm
[41] David Albright, „North Korea's Alleged Large-Scale Enrichment Plant: Yet Another Questionable Extrapolation Based on Aluminum Tubes", 23 February 2007
[42] http://www.iaea.org/NewsCenter/News/2007/dg_dprk_concludes.html

> would argue that the DPRK's investment in these programs has been a very bad investment, and the nuclear programs of the DPRK have been programs that have really helped impoverish that country. They do not buy prestige; they do not buy influence. Frankly, they buy a lot of isolation. I hope that if our little initial actions here can inspire some other countries to move on that course I would be very, very pleased indeed.[43]

However, one might note that these "little initial actions" come at a time when North Korea had already gone further than any other country in withdrawing from the Non-Proliferation Treaty and building and exploding a nuclear explosive device. Some experts consider that the most significant challenge in the North Korean case is to prevent the country from passing on bomb technology to other countries or even sub-national organisations. Siegfried S. Hecker, director of the American nuclear weapons development center Los Alamos National Laboratory from 1986 to 1997, had the unique opportunity to visit North Korean nuclear facilities in January 2004. He also held additional discussions with its technical leadership in Pyongyang in August 2005 and November 2006. In a March 2007 analysis he writes:

> North Korea also has a full range of nuclear technologies and skills that it can market to states or nonstate groups with nuclear-weapon aspirations. The highest priority goal of the six-party agreement must be to prevent such exports. (...) North Korea is unlikely to sell or outsource a nuclear weapon. It is also unlikely to simply sell its plutonium, although a grander bargain may be possible as outlined below. It may be much more likely to put its nuclear technologies and expertise on the market because it could claim these to be civilian transactions.[44]

The Iran Case

On 31 July 2006 the UN Security Council passed a resolution requesting Iran to „suspend all enrichment-related and reprocessing activities, including research and development, to be verified by the IAEA"[45] within one month. Iran did ignore the deadline pointing to its "inalienable right" to all parts of the nuclear fuel chain, as stipulated under Art. IV of the NPT.

On 27 October 2006 Iranian officials announced that they have put into operation a second cascade of 164 uranium enrichment centrifuges a few days before. An Iranian official said IAEA inspectors were present. The IAEA had indicated previously that it was aware that the second cascade would be ready for loading but did not comment on the Iranian declaration.

The Iranian move came only days after a draft resolution sponsored by France, the UK and the US was presented to other UN Security Council members calling for sanctions on Iran. As a first measure, it was proposed that IAEA technical assistance be cut off, with the explicit exception of the Bushehr nuclear power plant project. The exception is designed to attempt to get Russia onboard a possible move on sanctions. Russia is now the main builder of the Bushehr plant.

On 23 December 2006 the UN Security Council finally passed resolution 1737 that stipulates in particular:

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[43] http://www.state.gov/p/eap/rls/rm/2007/80499.htm

[44] Siegfried S. Hecker and William Liou, „Dangerous Dealings: North Korea's Nuclear Capabilities and the Threat of Export to Iran", http://www.armscontrol.org/act/2007_03/heckerliou.asp?print

[45] Security Council Resolution n°1696 (2006)

> 1. *Affirms* that Iran shall without further delay take the steps required by the IAEA Board of Governors in its resolution GOV/2006/14, which are essential to build confidence in the exclusively peaceful purpose of its nuclear programme and to resolve outstanding questions;
>
> 2. *Decides*, in this context, that Iran shall without further delay suspend the following proliferation sensitive nuclear activities:
> (a) all enrichment-related and reprocessing activities, including research and development, to be verified by the IAEA; and
> (b) work on all heavy water-related projects, including the construction of a research reactor moderated by heavy water, also to be verified by the IAEA;
>
> *3. Decides* that all States shall take the necessary measures to prevent the supply, sale or transfer directly or indirectly from their territories, or by their nationals or using their flag vessels or aircraft to, or for the use in or benefit of, Iran, and whether or not originating in their territories, of all items, materials, equipment, goods and technology which could contribute to Iran's enrichment-related, reprocessing or heavy water-related activities, or to the development of nuclear weapon delivery systems (…)

The resolution indeed explicitly excludes from the cooperation ban the supply of equipment for light water reactors and even low enriched uranium fuel in order to allow for the continuation of the Bushehr nuclear power plant project. On 9 February 2007 the IAEA Director General submitted a report to the Board of Governors on the Cooperation between the Islamic Republic of Iran and the Agency specifying the conditions of the trade restrictions.
The current state of nuclear capabilities remains an issue of controversy. The International Institute of Science and International Security (ISIS), stated in a testimony before the US Congress:

> Most are skeptical that Iran can finish installing 3,000 centrifuges in May 2007, let alone getting them all to enrich uranium. (...) Few would doubt that at this point Iran has a nuclear weapons capability, whether or not the plant produces HEU [High Enriched Uranium]. This number of centrifuges could make enough highly enriched uranium for one or two nuclear weapons per year, or create a large stockpile of low enriched uranium that could be used in a break-out strategy to produce HEU quickly either in the same facility or in a covert centrifuge plant. This benchmark could be reached within a year or two.[46]

The latest nine-month episode is only the last one in a long history of Iran's nuclear program. It all started under the Shah in the 1950s that launched an ambitious nuclear research and development program, just as many industrialised nations did in the follow-up of the US initiated Atoms for Peace program. Iran was one of the first countries to sign the NPT in 1968 and ratified it in 1970. The Safeguards Agreement was signed in May 1974 but the Additional Protocol only in December 2003.

The signature of the safeguards agreement in 1974 paved the way for the German company Siemens-KWU (now part of AREVA NP) to sign a contract for the delivery of two light water

[46] David Albright, „Iran's Nuclear Program: Status and Uncertainties", Prepared testimony before the House Committee on Foreign Affairs, Subcommittee on Terrorism, Nonproliferation, and Trade, Subcommittee on the Middle East and Asia, Institute for Science and International Security (ISIS), March 15, 2007

reactors at Bushehr and to start construction in May 1975. After the "revolution" in 1979 Siemens was forced to abandon the project. It was taken up by the middle of the 1980s by the Russian nuclear industry. The project, now listed as "under construction" by the IAEA for 31 years is the world record holder for extended construction times. Currently start up of the first unit is projected for 2007 while there is no target date yet for the second unit.

Very early Iran was integrated into the small community of uranium enriching countries. On 23 February 1974, even before the signature of the safeguards agreement with the IAEA, France signed an agreement with Iran that created the company SOFIDIF[47]. Iran put up over a $ 1 billion and was in turn to receive 10% of the produced enriched uranium. The latter part of the deal was never honoured and the conflict went on for ten years until the International Chamber of Commerce in January 1991 awarded Iran the equivalent of € 143 million as part of the settlement, to be added to some € 500 million that had already been paid. A final settlement agreement, whose details have remained secret, has been signed between France and Iran in October 1991. France is said to have agreed to pay another $ 1 billion. However, it remains uncertain whether this includes part of the payments carried through before.

In 1975 SOFIDIF took up a 25% share in the international EURODIF consortium that built a large uranium enrichment facility in Pierrelatte in the south of France. SOFIDIF still exists, still holds the same share in EURODIF and is still active. In a letter dated 13 February 2006 (see Annex 5), addressed to the CEO of SOFIDIF, Reza Aghazadeh, Vice-President of Iran and President of the Iranian Atomic Energy Organisation, informs about the replacement of the Iranian representatives on the board of SOFIDIF. As recalled during SOFIDIF's most recent General Assembly on 16 June 2006, the purpose of the company is "to participate in the study, the realisation and the operation of uranium enrichment plants based on the French gaseous diffusion technique".[48] The operation is good business for the EURODIF shareholders. SOFIDIF reached a net profit of € 17.7 million and decided to pay out € 17.6 million in dividends. This corresponds to € 12.80 per share – on steady increase and twice as much as 2002 – which is excellent return on investment, considering the share value of € 15.25 each. The Iranian Atomic Energy Organisation had a net income from dividends in 2005 of € 12.8 million from uranium enrichment in France.

At the same time Iran has been accused of a number of serious breeches of its obligations under the NPT. In November 2004, the IAEA Board of Governors makes public a 32-page document with an unusually detailed account of Iran's omissions under the NPT Safeguards Agreement (see summary in Annex 4). If many of the issues seem to have been cleared up, but matters of "serious concern" remain, as the Director General of the IAEA has reported to the IAEA General Conference in September 2006. While the Director General confirms that "all the nuclear material declared by Iran to the Agency has been accounted for", because of "outstanding issues relevant to the scope and nature of Iran's current and past centrifuge enrichment programme, the Agency cannot make any further progress in its efforts to provide assurances about the absence of undeclared nuclear material and activities in Iran".

There are analysts that consider that Iran is not aiming at the fabrication of nuclear weapons but rather target a "virtual deterrence" capacity. Nader Barzin's hypothesis, based on extensive research on primary sources and interviews with key Iranian stakeholders, is that after the invasion of Iraq and the "encirclement" by the US, Iran felt it had to respond, but in another way than North Korea.

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[47] 60% French Atomic Energy Commission, later COGEMA and today AREVA NC, 40% Iranian Atomic Energy Organisation (OEIA)

[48] Rapport de gestion à l'Assemblée Générale Ordinaire concernant l'exercice clos le 31 décembre 2005

> The Iranian response has been subtler: making its capacities known – deter – without going up to the fabrication of weapons – thus remaining in legality, respecting the terms of the NPT, and showing its good international citizenship.[49]

Barzin is convinced that the Iranian enrichment programme had been known to US intelligence for a long time but that the Iranians decided themselves to release the information in order to demonstrate a virtual nuclear weapons capability. However, it is perfectly clear that if Iran settles the IAEA's "outstanding issues", there is nothing in international law that could prevent the country from establishing a full-scale uranium enrichment and plutonium separation programme. On the contrary, according to Article IV of the NPT, in principle the IAEA is obliged to provide technical assistance.

[49] Nader Barzin, *L'Economie Politique de Développement de l'Energie Nucléaire en Iran, (1957-2004),* Thèse de Doctorat, Ecole des Hautes Etudes en Sciences Sociales, 23 June 2004

Summary and Conclusions

Students Designing a Nuclear Bomb

There are few developments that could have more impact on our societies than the use of nuclear weapons by a government or even a sub-national group. Substantial controversy surrounds the question how much of a technical challenge constitutes the actual fabrication of a nuclear explosive device. That is wrongly so. The question has been answered 40 years ago.

On 14 December 1966 two American post-doc physics students delivered a report called "The Nth Country Fission Weapon Design" that had a thick "secret" stamp on top and bottom of each single page. The report has been partially declassified in 2003. The two had finalised a project initiated two and a half years earlier by the Lawrence Radiation Laboratory, one of the US nuclear bomb laboratories, and called the "Nth Country Experiment". The purpose of the experiment was "to find out, if a credible nuclear explosive can be designed, with a modest effort, by a few well-trained people without contact with classified information". In addition, the participants had been asked "to design a nuclear explosive which, if built in small numbers, would give a small nation a significant effect on their foreign relations".

It took the two young physicists[50] about three person-years of work to come up with a design that has been confirmed as workable by US top nuclear weapon experts. They had chosen a Nagasaki type plutonium implosion weapon, much more difficult to design than a "gun-type" uranium explosive device, which the young ambitious scientists obviously considered "too simple a project to build a reputation on".

Conclusion on Sub-National Nuclear Capabilities

Physicists without any particular education and training have designed a nuclear explosive device in a very short time. If the task took 3 person-years 40 years ago on the basis of open literature without computer assistance, it would take a group of a dozen dedicated talented scientists probably only a few weeks to elaborate a workable nuclear explosive device.

Sub-national Groups Keen to Acquire the Bomb

There is absolutely no doubt that not only a number of states but various sub-national groups have shown interest and have demonstrated considerable technical and financial capacities indispensable for the acquisition of nuclear and other weapons of mass destruction. There are a number of striking statements in that respect, including by various intelligence officials. Graham Allison, director of the Belfer Center for Science and International Affairs at Harvard's John F. Kennedy School of Government and author of *Nuclear Terrorism: The Ultimate Preventable Catastrophe*, concluded: "In sum, my best judgment is that based on current trends, a nuclear terrorist attack on the United States is more likely than not in the decade ahead." The French 2006 White Book on Terrorism even states that "several terrorists arrested in France since 2001 had been involved with terrorist projects that included a rudimentary non-conventional aspect".

Conclusion on Interest of Sub-National Groups in Nuclear Explosives

Various sub-national groups have already demonstrated interest in weapons of mass destruction, including nuclear explosives.

[50] One of them has been replaced after about a year but they have never been more than two working on the design.

Critical Mass the Size of a Coke Can

If the nuclear weapon design is straight-forward and does not constitute a significant barrier for an interested and motivated state or sub-national group to acquire nuclear explosives, the access to fissile materials gets a key role.

Uranium and plutonium are dense heavy metals. The respective quantities needed in order to manufacture a nuclear weapon can be drastically reduced by various technical means. The application of a neutron reflector would bring down the critical mass of high-enriched uranium to less than 12 kg with a diameter of 11 cm, the size of a small cantaloupe. The critical mass for plutonium would be reduced by the same means to less than 4 kg with a diameter of about 7 cm, the size of an orange.

Conclusion on Critical Masses

In the case of a successful diversion, the **detection** of small quantities of strategic fissile materials in transit constitutes a **very major challenge**. The 6 kg of plutonium contained in the Nagasaki bomb would easily fit in a coke can and can be shielded easily.

How Much for a Kilogramme of Plutonium?

Between 1993 and 2005, the International Atomic Energy Agency's Illicit Trafficking Database (ITDB) has registered 827 confirmed incidents of which 224 incidents involved nuclear materials and the rest mainly other radioactive materials. In 16 cases plutonium or high-enriched uranium was involved. While most of the quantities seized were very small, a few cases involved kilogram quantities and all incidents demonstrate that there are sources for this kind of material and ways to extract it from facilities.

The official US 911 Commission has established that Al Qaeda "was actively trying to obtain nuclear material" and "has tried to acquire or make nuclear weapons for at least ten years".

US intelligence services consider that significant amounts of Russian nuclear material has gone missing. The CIA Director has stated: "There is sufficient material unaccounted for, so that it would be possible for those with know-how to construct a nuclear weapon." Some European nuclear security officials consider Pakistan as the most problematic region.

Conclusion on Black Market for Nuclear Materials

There is an identified **black market** for nuclear materials, including plutonium and highly enriched uranium. According to US intelligence services, significant amounts of Russian nuclear materials are unaccounted for.

Plutonium and HEU on a Tray

Some countries have established nuclear fuel systems involving the frequent shipment over long distances of large quantities of unirradiated **plutonium**, either in the form of separated plutonium powder or fresh plutonium fuels (MOX). France and the UK operate plutonium separation and MOX fuel fabrication plants. In order to fuel the French system alone, 90 shipments, on average about twice a week year round every year, each one containing about 150 kg of separated plutonium, role over 800 km of French roads.

High-enriched uranium is only used in nuclear weapons and in research reactors. While many research reactors, considered to be a proliferation hazard, have been converted to low-enriched uranium, there are still over 60 that operate with high-enriched uranium fuels. Each fuel shipment to and from the reactor constitutes a proliferation risk.

Conclusion on Proliferation Risks From Nuclear Industry Activities

Europe is the centre of commercial plutonium operations and shipments. Germany has built the only recent research reactor operating with weapons grade uranium. Road and sea shipments of plutonium and high-enriched uranium constitute a prime target for hijacking or attack attempts by states and sub-national groups.

Theft of Nuclear Materials by States

Nuclear materials have not only been stolen and made available on the Black Market, but been diverted by states. Israel has hijacked a uranium shipment on the high seas in 1968 ("Plumbat Affair") and has probably also stolen, the same year, about 100 kg of high-enriched uranium from a US naval fuel manufacturing plant ("NUMEC Affair"). Several other countries, including Pakistan, South-Africa, Iran, Iraq and Libya have used illegal means to obtain nuclear equipments and materials.

Conclusion on the Risk of Theft of Nuclear Materials by States

There have been several documented cases of theft of nuclear materials and large-scale illegal nuclear purchasing activities by states in the past and there is no reason to exclude such activities by states in the future.

The NPT: Violated from Day 1

The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) has "a rather disappointing record", as the prestigious Stockholm International Peace Research Institute (SIPRI) puts it in its Yearbook 2006. The NPT, signed in 1968, was and is considered a political bargain between the Nuclear Weapon States (NWS) and the Non-Nuclear Weapon States (NNWS), between the have and the have not states. The NWS committed themselves to full disarmament and the NNWS not to acquire nuclear weapons in the first place. In addition, the Treaty guarantees full access to "civil" nuclear technology.

The NPT has been violated from day one. The NWS, in particular the US and the Soviet Union have massively increased the numbers and qualities of their nuclear weapons stockpiles until the end of the 1980s. As of 2005, 35 years after the NPT entered into force, the US and Russia still owned some 26,000 nuclear weapons. The US has practically not reduced its stockpile over the last 10 years and has launched the development of new generations of nuclear weapons. In addition, the US still deploys some 480 nuclear weapons in European NNWS (Belgium, Germany, Italy, Netherlands, Turkey), maintains nuclear bombing ranges in these countries and trains pilots from these countries to deliver US nuclear weapons.

Conclusion on the NPT

The nuclear weapon states continue to violate the NPT as long as nuclear disarmament is stagnating, nuclear weapons remain deployed in non-nuclear weapon states and new nuclear weapon systems are being developed.

The IAEA: Less Money than the Vienna Police Department

The International Atomic Energy Agency (IAEA) has to maintain a verification system that should allow the detection of undeclared activities at about 900 facilities in some 70 countries. However, the IAEA has been notoriously underfunded for many years. The IAEA's entire safeguards budget is hardly more than € 100 million, about a third of the budget of the Vienna police department.

The EURATOM safeguards inspection efforts are on a continuous decline while the amount of nuclear materials under control has increased steadily (e.g. plutonium tripled). The Commission spends about € 13 million per year on safeguards.

> The IAEA is notoriously underfinanced. The IAEA's Director General likes to compare the financial capacities of his organisation with the budget of the Vienna police department.
>
> The equally modest EURATOM safeguards budget corresponds to about half of the annual budget of the international industry lobby organisation Nuclear Energy Institute (NEI). The number of inspection days is continuously decreasing.

The North Korea Case: What has Triggered the Country to go Military?

North Korea withdrew from the NPT in January 2003 and carried out a nuclear test in October 2006. This is the first time that a member state withdraws from the NPT, an option perfectly legal under Article X.

The US government has claimed that North Korea had admitted to a secret military uranium enrichment program in a meeting in October 2002, a claim the North Korean government has always refuted. The US government has never produced any evidence of its claims.

The reactor construction project, initiated by the 1995 KEDO – North Korean agreement, was several years behind before it was frozen in 2003.

> ***Conclusion on the North Korea Case***
>
> The North Korean nuclear test three and a half years after withdrawal from the NPT has isolated the country even more than before and further undermined the credibility of the NPT. The question remains, how events were triggered and why the country turned away from some timid opening initiatives up to October 2002. The US government has never produced any evidence for its allegations of a North Korean secret weapons agenda.

The Iran Case: Dividends on Enrichment in France, Sanctions on Enrichment in Iran

Iran has started nuclear research and development as early as in the 1950s. Many countries have given their support over the years, including the US, France, Germany and Russia that is currently finishing the reactor project at Bushehr. The UN Security Council has requested Iran to halt its domestic uranium enrichment program, although under IAEA control, pending the fulfilment of some outstanding verification issues. At the same time, Iran is receiving lucrative dividends from its 10% participation in the international EURODIF uranium enrichment plant in France, € 12.8 million on the result of year 2005. Iran insists on its inalienable right under Article IV of the NPT to nuclear technology.

> ***Conclusion on the Iran Case***
>
> The Iran case illustrates limits and widespread misunderstanding of the NPT. While Iran claims its legitimate right under the NPT to carry out uranium enrichment, it has not fulfilled a number of IAEA verification requests. The sanction requested by the UN Security Council, that is to halt enrichment operations, are not to be confounded with a prohibition to enrich. While public attention has focussed on the situation in Iran, nobody seems to be aware of the fact that Iran is still a shareholder of the world's largest uranium enrichment plant EURODIF in France and receives considerable dividends.

General Conclusion

Forty years ago, the Nth Country Experiment has proven that a couple of post doc physics students can design a nuclear weapon on the basis of public literature in less than three years. It is obvious that in times of widespread computer and internet availability there is no doubt that even a small group of motivated and dedicated scientists could design a nuclear explosive device in a matter of weeks.

The main hurdle for the actual building of a nuclear bomb is the availability of the primary fissile material, plutonium or high-enriched uranium. Depending on the design of the device, quantity and volume of the necessary plutonium can be extremely small and easy to hide. The 6 kg contained in the Nagasaki bomb would fit in a coke can.

A black market in nuclear materials has been identified. US intelligence services consider that quantities of nuclear materials *known* to be unaccounted for, in particular in Russia, are sufficient for the manufacturing of nuclear explosives and that undetected smuggling has occurred.

Various sub-national groups, and Al Qaeda in particular, have demonstrated interest in nuclear weapons for a period of at least ten years.

Some countries, France and the UK in particular, operate nuclear systems that involve dozens of national and international road and sea shipments of plutonium per year, each carrying between 135 kg and 245 kg of unirradiated plutonium. These shipments constitute a particular easy and obvious target for attack. In a post-911 world, the continuation of this high-risk activity, that contributes little to the overall energy balance, seems increasingly unjustifiable.

The Non-Proliferation Treaty (NPT) has proven inefficient as a disarmament tool. It has cemented the “privilege” of the nuclear weapon states and explicitly aims at the dispersion of nuclear technology that can be – and has been – used for military purposes. The NPT has turned out to be just as much a Proliferation Treaty. Its profound renegotiation is indispensable, just as the negotiation of a treaty that bans all weapons usable fissile material production.

Finally, the Iran case illustrates the hypocrisy of current diplomacy on the issue. While massive political pressure is mounted to push Iran to abandon its domestic enrichment programme, Iran is free to cash in on lucrative dividends from its 10% participation in the international EURODIF enrichment plant operation in France. Under the NPT Iran has the right to access the full range of “civil” nuclear technology, including uranium enrichment and plutonium separation. While there are a number of “outstanding issues” with the IAEA on verification and access to facilities, so far and as far as documented, there is no indication that Iran has diverted materials or facilities for military purposes.

This is the problem inherent to the nuclear issue and the NPT: it is the perfect tool to establish a full scope “civil” nuclear program and to profit from international assistance to acquire a “latent” nuclear weapon capacity. Several countries have gone down this path in the past. North Korea is only the latest example. Iran might not even have to build nuclear weapons, it could operate according to the logic of “virtual deterrence”. And it could still later follow the North Korean example and withdraw from the NPT should it wish to go down the weapons path. The Nth Country Experiment continues. Who is next?

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Annexes

Annex 1: Countries with Nuclear Weapons or Programs, Past and Present

NPT NUCLEAR WEAPON STATES China France Russia United Kingdom United States	**RECENTLY TERMINATED PROGRAMS** Iraq Libya
NON-NPT NUCLEAR WEAPON STATES India Israel Pakistan	**PROGRAMS ENDED BETWEEN 1970–1980**[a] Australia Egypt Germany Italy Japan Norway Sweden
SUSPECTED PROGRAMS Iran North Korea	**PROGRAMS ENDED AFTER 1980** Argentina Brazil Romania South Africa South Korea Spain[b] Switzerland Taiwan Yugoslavia
SUSPECTED PROGRAM INTENTIONS— NO PROGRAM IDENTIFIED Algeria[c] Indonesia Nigeria[d] Saudi Arabia[e] Syria	**INHERITED WEAPONS—NOW NONNUCLEAR WEAPON PARTIES TO THE NPT** Belarus Kazakhstan Ukraine

Note: Thirty-six countries in total.

a Some political leaders in Germany, Italy, Japan, and Norway advocated nuclear weapons research, but the programs never became government policy.

b There is no evidence of a nuclear weapons program in Spain, although it is widely believed that a program existed.

c Joseph Cirincione, Jon Wolfsthal, and Miriam Rajkumar, *Deadly Arsenals: Tracking Weapons of Mass Destruction* (Washington, D.C.: Carnegie Endowment for International Peace, 2002), 299.

d Mentions of Indonesia and Nigeria are infrequent.

e Saudi Arabia is not believed to have an active nuclear weapon program. However, there is documented debate among the highest levels in Riyadh regarding the option to acquire a nuclear deterrent. See Ewen MacAskill and Ian Traynor, "Saudis Consider Nuclear Bomb," *Guardian*, September 18, 2003, available at www.guardian.co.uk/saudi/story/0,11599,1044402,00.

*Source: George Perkovitch et al., "*Universal Compliance – A Strategy for Nuclear Security"*, Carnegie Endowment for International Peace, June 2004*

Annex 2: Nobel Committee Statement the Nobel Peace Prize 2005 for the IAEA and its Director General Mohamed ElBaradei

"The Norwegian Nobel Committee has decided that the Nobel Peace Prize for 2005 is to be shared, in two equal parts, between the International Atomic Energy Agency (IAEA) and its Director General, Mohamed ElBaradei, for their efforts to prevent nuclear energy from being used for military purposes and to ensure that nuclear energy for peaceful purposes is used in the safest possible way."

"At a time when the threat of nuclear arms is again increasing, the Norwegian Nobel Committee wishes to underline that this threat must be met through the broadest possible international cooperation. This principle finds its clearest expression today in the work of the IAEA and its Director General. In the nuclear non-proliferation regime, it is the IAEA, which controls that nuclear energy is not misused for military purposes, and the Director General has stood out as an unafraid advocate of new measures to strengthen that regime. At a time when disarmament efforts appear deadlocked, when there is a danger that nuclear arms will spread both to states and to terrorist groups, and when nuclear power again appears to be playing an increasingly significant role, IAEA's work is of incalculable importance."

"In his will, Alfred Nobel wrote that the Peace Prize should, among other criteria, be awarded to whoever had done most for the "abolition or reduction of standing armies". In its application of this criterion in recent decades, the Norwegian Nobel Committee has concentrated on the struggle to diminish the significance of nuclear arms in international politics, with a view to their abolition. **That the world has achieved little in this respect makes active opposition to nuclear arms all the more important today**."

Oslo, 7 October 2005

Annex 3: Nuclear Materials Transport in France

Table 2 **Estimates of the total quantities of nuclear materials shipped in one year of plutonium transports in France (tML Uranium and/or Plutonium)**

	EDF	Foreign	Total
Plutonium oxide powder	*7*	*5*	**12**
Products of MOX fabrication plants	***100***	***40***	**140**
including:			
Fresh MOX fuel	97	39	*136*
MOX scraps	3	1	*4*
Total	**107**	**45**	**152**

Source: Mycle Schneider Consulting, derived from [WISE-Paris 2003]

Table 3 **Estimates of the number of packages shipped in one year of the plutonium transports in France (number of packages)**

	EDF	Foreign	Total
Plutonium oxide powder	***50***	***39***	**89**
Products of MOX fabrication plants	***50***	***18***	**68**
including:			
Fresh MOX fuel	27	11	***38***
MOX scraps	23	7	***30***
Total	**100**	**57**	**157**

Source: Mycle Schneider Consulting, derived from [WISE-Paris 2003]

Table 4 **Estimates of the quantities of plutonium shipped in one year of the plutonium transports in France (tPu)**

	EDF	Foreign	Total
Plutonium oxide powder	*7*	*5*	**12**
Products of MOX fabrication plants	*7*	*3*	**10**
Total	**14**	**8**	**22**

Source: Mycle Schneider Consulting, derived from [WISE-Paris 2003]

Annex 4: Summary of conclusions of the IAEA Report on the Implementation of the NPT Safeguards Agreement with Iran, Vienna, 15 November 2004

a. Failure to report:

(i) the import of natural uranium in 1991, and its subsequent transfer for further processing;

(ii) the activities involving the subsequent processing and use of the imported natural uranium, including the production and loss of nuclear material where appropriate, and the production and transfer of waste resulting therefrom;

(iii) the use of imported natural UF6 for the testing of centrifuges at the Kalaye Electric Company workshop in 1999 and 2002, and the consequent production of enriched and depleted uranium;

(iv) the import of natural uranium metal in 1993 and its subsequent transfer for use in laser enrichment experiments, including the production of enriched uranium, the loss of nuclear material during these operations and the production and transfer of resulting waste;

(v) the production of UO2, UO3, UF4, UF6 and ammonium uranyl carbonate (AUC) from imported depleted UO2, depleted U3O8 and natural U3O8, and the production and transfer of resulting wastes; and

(vi) the production of natural and depleted UO2 targets at ENTC and their irradiation in TRR, the subsequent processing of those targets, including the separation of plutonium, the production and transfer of resulting waste, and the storage of unprocessed irradiated targets at TNRC.

b. Failure to declare:

(i) the pilot enrichment facility at the Kalaye Electric Company workshop; and

(ii) the laser enrichment plants at TNRC and the pilot uranium laser enrichment plant at Lashkar Ab'ad.

c. Failure to provide design information, or updated design information, for:

(i) the facilities where the natural uranium imported in 1991 (including wastes generated) was received, stored and processed (JHL, TRR, ENTC, waste storage facility at Esfahan and Anarak);

(ii) the facilities at ENTC and TNRC where UO2, UO3, UF4, UF6 and AUC from imported depleted UO2, depleted U3O8 and natural U3O8 were produced;

(iii) the waste storage at Esfahan and at Anarak, in a timely manner;

(iv) the pilot enrichment facility at the Kalaye Electric Company workshop;

(v) the laser enrichment plants at TNRC and Lashkar Ab'ad, and locations where resulting wastes were processed and stored, including the waste storage facility at Karaj; and

(vi) TRR, with respect to the irradiation of uranium targets, and the facility at TNRC where plutonium separation took place, as well as the waste handling facility at TNRC.

d. Failure on many occasions to cooperate to facilitate the implementation of safeguards, as evidenced by extensive concealment activities.

87. As corrective actions, Iran has submitted inventory change reports (ICRs) relevant to all of these activities, provided design information with respect to the facilities where those activities took place, and presented all declared nuclear material for Agency verification, and it undertook in October 2003 to implement a policy of cooperation and full transparency.

88. Further corrective actions may be identified by the Agency as a consequence of assessments that are still ongoing.

Annex 5: OEAI Letter to CEO of SOFIDIF

REPUBLIQUE ISLAMIQUE D'IRAN
ORGANISATION DE L'ENERGIE ATOMIQUE DE L'IRAN

Monsieur Christian GOBERT
Président du Conseil d'Administration
SOFIDIF
2 rue Paul Dautier
78140 VELIZY VILLACOUBLAY
France

Réf. : 30/103627
Date : 13 Février 2006

Cher Monsieur GOBERT,

Je souhaite vous informer que :

1. Dr Mohammad SAEIDI est désigné comme nouveau représentant permanent de l'OEAI au sein du Conseil d'Administration de SOFIDIF. J'attire votre attention sur le fait que Dr M. SAEIDI a actuellement le poste de Vice Président de planification et affaires internationales de l'OEAI.

2. Mr Hossein HOSSEINI devient par ailleurs mon représentant au sein du Conseil d'Administration de SOFIDIF. Mr HOSSEINI occupe le poste de conseiller scientifique et technique auprès du Président de l'OEAI.

Je vous remercie de bien vouloir faire le nécessaire afin que Mr HOSSEINI puisse également représenter SOFIDIF au Conseil de Surveillance (Conseil de Surveillance) d'EURODIF.

Avec mes meilleurs sentiments.

Reza AGHAZADEH
Vice Président de la République Islamique d'Iran
et Président de l'OEAI