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"Military Sales and Nuclear Proliferation, Disarmament and Arms Control"

The twin problem of warheads and their delivery vehicles. Where to put the priority during future treaty negotiations?

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INTRODUCTION

Since the end of World War II there has been a number of treaties dealing with the limitations, reductions and elimination of so-called weapons of mass destruction and/or their transport systems (generally called delivery systems). Some of the treaties are bilateral, others multilateral, or in rare cases universal.

The term **weapons of mass destruction** (WMD), used to encompass nuclear (NW), biological (BW), and chemical weapons (CW), is misleading, politically dangerous, and can not be justified on grounds of military efficiency. This had been pointed out earlier [1] and discussed recently in considerable detail by W.K.H. Panofsky.[2] Whereas protection against chemical and biological weapons is possible, however inconvenient it might be for military forces on the battlefield and for civilians, it is not feasible at all against nuclear weapons. Chemical weapons have shown to be largely ineffective in warfare, biological weapons have never been tried out on any significant scale. Both types should be better designated as **weapons of terror** against civilians. Requirements on their transport system differ vastly from those for nuclear warheads. Stockpiling of biological weapons is not even possible over a long time scale. Only nuclear weapons are completely indiscriminate by their explosive power, heat radiation and radioactivity, and only they should therefore be called a weapon of mass destruction.

The above arguments are further substantiated by a United Nations study [3], that compared the hypothetical results of an attack carried out by one strategic bomber using either nuclear, chemical or biological weapons. A one-megaton nuclear bomb, the study found, might kill 90 percent of unprotected people over an area of 300 square kilometer. A chemical weapon of 15 tons might kill 50 percent of the people in a 60 square kilometer area. But a 10 ton biological weapon could kill 25 percent of the people, and make 50 percent ill, over an area of 100,000 square kilometers. These efficiencies assume that chemical and biological agents can be spread over a large surface and reach the ground level.

In the present paper emphasis will be put on treaties, which deal with nuclear weapons and the means to get them to an envisaged target. Weapons are mostly defined by the owner's military establishment or manufacturer as *defensive* or *deterrent*. It is close to impossible to draw a line between defensive or aggressive weapons. The ambiguous value of *deterrence* will not be discussed.

A short list of treaties, not including any of their (present or planned) amendments, follows. Their acronyms, year of signature and/or entry into force (ratification), as well as the main participating parties are indicated. A detailed discussion of these treaties is beyond the scope of this paper; an evaluation as well as their complete text can be found e.g. in ref. [4].

Non-**P**roliferation **T**reaty, **NPT** (1968 signed, 1970 into force),
Nuclear and Non-nuclear Weapon States.

Anti-**b**allistic **M**issile **T**reaty, **ABM** (1972 signed and into force),
Bilateral: USA and USSR.

Missile **T**echnology **C**ontrol **R**egime, **MTCR** (1987 signed by Canada, France, FR. Germany, Italy, Japan, UK, USA, but not e.g. by *India*, *Pakistan & North-Korean*). Not a formal treaty.

Intermediate-range and Shorter-ranger **N**uclear **F**orces, **INF** (1987 signed, 1988 into force),
Bilateral: USA and USSR.

Strategic **A**rms **R**eduction **T**reaty **I**, **START I** (1991 signed, 1994 into force),
Bilateral: USA and former USSR.

Strategic **A**rms **R**eduction **T**reaty **II**, **START II** (1993 signed, *not yet ratified by Russian Duma*),
Bilateral: USA and former USSR.

Indefinite extension of the **N**on-**P**roliferation **T**reaty, **NPT** (1995, signed by ~180 countries, but not by *India*, *Pakistan*, *Israel*),
Nuclear and Non-nuclear Weapons States.

Comprehensive **T**est **B**an **T**reaty, **CTBT** (1996 signed by >131 countries, need ratification by 44countries, includding India. Not yet fatified e.g. by *USA and Russia*. India and Pakistan are not signatory countries. This treaty may be respected, but never enter into force).
Nuclear and Non-Nuclear Weapon States.

Strategic **A**rms **R**eduction **T**reaty **III**, **START III**,
Bilateral: USA and Russia,
Under discussion (Helsinki declaration in March 1997 of Presidents Clinton and Yeltsin).

WHAT DO THE TREATIES INPLY?

The public at large is rarely informed about the contents of the above listed treaties. This is mainly the fault of the media, who hesitate to give information which is hard to digest or might be boring to read. Furthermore, governments might not be inclined to create anxiety in the population. A single nuclear test explosion may make headlines, an information on the enormous stockpile of nuclear arms and their devastating potential, by accidental or intended use, is largely missing. The majority of citizens is lulled into the belief that nuclear arms are gradually disappearing from out planet due to INF, START I and START II, and the prohibition (?) of development of new weapons by the CTBT. These treaties are aiming **mainly** to reduce the carrier of nuclear arms, preventing their immediate use, but only marginally at elimination of the weapons themselves. This procedure presents only that part of disarmament, which appears to be easily verifiable, but misses the essential core, namely the destruction of warheads and elimination of fissile material. Both processes are on a slow track. Unfortunately, the *reduction in numbers of weapons* in the declared nuclear weapon states (NWS) is accompanied by improvement of their efficiency, transport systems, and targeting accuracy.

Warheads and delivery systems will first be treated separately, followed by recent information of their cost for the United States.

Nuclear Warheads

The bilateral treaty on **i**ntermediate and short-range **n**uclear **f**orces (INF), also denominated treaty on tactical forces, was a first step on the way to negotiations on reduction of so-called strategic nuclear weapons. Following the successful conclusion of START I, the bilateral START II agreement between the former USSR (now Russia) and the United States stipulated that by the year 2003 (now postponed to year 2007) both countries could ***deploy*** no more than 3,000 to 3,500 strategic nuclear warheads on **i**nter-**c**ontinental **b**allistic **m**issiles (ICBMs), **s**ubmarine-**l**aunched **b**allistic **m**issiles (SLBMs), and bombers.

Additional limits (in a short form) set forth by the START II treaty are:

- No **m**ultiple **i**ndependently targeted **r**e-entry **v**ehicles (MIRVs) on land-based missiles.
- All SS-18 “heavy” Russian missiles must be destroyed.
- No more than 1,700 to 1,750 warheads (about one-half the US Trident warhead loading projected under START I) may be deployed on SLBMs.
- Reductions in strategic nuclear warheads, as well as the deMIRVing of ICBMs, may be achieved by “downloading” (removing) warheads from a missile.
- Once removed, warheads may not be restored to downloaded missiles.

There is no word on the dismantling of the warheads themselves in the treaty.

Progress on START treaties can be summarized as follows: From September 1990 to January 1998 there has been an overall reduction in absolute numbers of deployed warheads from 10,563 to 7,986 in the USA, and from 10,271 to 6,680 in the Soviet/Russia Strategic Forces [5]. START I treaty requirements have been obtained by the US, but not yet fully by Russia. None of the two countries has achieved in any of the different categories of delivery systems the goal set by START II. It is worrying, that the numbers of the sophisticated, modern and more powerful warheads has considerably increased during this period, contrary to the spirit of the treaty [5]. There is clearly no sign that the two powers are acting according to Article VI of the NPT. Other indications for non-compliance are outlined in the Nuclear Stockpile Stewardship Program [6], the future of designing nuclear weapons and simulating nuclear explosions [7], and the planned involvement of universities in weapons design [8].

There is a large grey zone as far as the weapons in hedge are concerned, which consists mainly of tactical nuclear warheads. At the end of 1995 there were in the US about 13,000, in Russia about 26,000 intact nuclear warheads [9].

START III envisages a limit of 3,500 strategic weapons for both partners.

There is no nuclear arms reduction treaty with participation of the other three NWSs.

It can be assumed that most of the industrial countries are capable to built (rudimentary) nuclear weapons within delays of a few months to a few years, provided fissile material is available or can be procured. The stockpile of weapon-grade material is enormous and given in table 1 (on the average only 4 kg Pu and/or 15 kg HEU are needed for building one weapon).

	Pu [to]	HEU [to]
Inside weapons	75	485
Unknown destination	77	553
Declared excess	74	674
Under Safeguards	2	10
Total	**228**	**1,722**

Table 1 (extracted from [10])

In addition to the above tonnage one has to take into account fuel-grade (~82-93% Pu^{239}) and reactor-grade plutonium (~70-82% Pu^{239}), amounting in the US to 13.2 and 1.3 tons, respectively [10].

There is still a controversy going on as far as the usability of reactor-grade plutonium for weapon construction is concerned. Information about the (only?) *US 1962 test* of a weapon using reactor-grade plutonium was withheld for three decades by the government. Only in 1994 and 1996 incomplete data were made available by DOE, which have been discussed by A. DeVolpi [11]. He came to the conclusion that either the information on the quality of the fissile material or the claimed explosive yield was incorrect, resulting in inherent difficulties in weaponization of civilian plutonium. In a reply to this article, M. Miller and F. von Hippel took an opposing position [12, 12a], earlier stated in [13]. I share the opinion of von Hippel that reactor-grade material can be used as it is or after reprocessing to built (rudimentary) weapons, requiring however (some) redesigning of warhead, special care of protection against radioactivity during manufacturing and storage, and at the expense of a lower explosion yield and inherent safety. There was no need in the declared NWSs to go this tedious way, since there is and was plenty of weapon-grade plutonium available. However, any rogue state, determined to go nuclear, would probably disregard such drawbacks.

Many of the ~440 operational civil nuclear reactors are able to produce some plutonium. A complete elimination of nuclear power reactors is not feasible or even desirable on any foreseeable time scale due to the ever increasing demand of electricity. Therefore, as a first step a cut-off treaty for weapon-grade material should be concluded, followed by better international surveillance of reactor-grade of plutonium.

Tritium, with a half-life of 12.3 years, plays an important role in all modern nuclear weapons. It is being used for boosting weapons of the first generation, for improved primaries in the second generation, for building thermonuclear devices, and for so-called neutron bombs [14, 15,16]. Large stocks of tritium are available and are being used to replace the decaying part in weapons. Tritium serves to increase the **yield-to-weight ratio** of nuclear warheads, reaching, e.g. for the B53-bomb and the W53 warhead of the Titan II missile a yield of 2,200 tons TNT per Kilogram (488 times the yield/weight ratio of “Fat Man”, the Nagasaki bomb; 586-733 times that of “Little Boy”, the Hiroshima bomb).

The Delivery Systems

Delivery systems for nuclear warheads can be subdivided in cannons, aircraft, and land-based **i**nter-**c**ontinental **b**allistic **m**issiles (ICBMs) or **s**ubmarine-**l**aunched **b**allistic **m**issiles (SLBMs).

Usually, there is made a distinction between *strategic* and the *tactical* nuclear weapons, the first to travel fast over long distances, the second intended to be used on the battle field. This differentiation may make some sense for military planners, but takes not into account that nuclear weapons remain indiscriminate. Time of delivery to the target depends only marginally on the transport device, but much more on its location prior to delivery. Nowadays similar yields can be obtained with strategic and tactical weapons. A warhead with an explosive power twenty times the one of the Hiroshima bomb can be easily transported by fighter planes over short distances, like a F16, taking off from a carrier. Weapons weighing some 50 kg have the explosive power of several kilotons TNT. Employment of these weapons on the battle field close to the own troops would be counterproductive, mainly due to the spreading cloud of radioactivity.

The relative inefficiency of transporting bombs by airplanes over long distances had been demonstrated during WW II, when British air defenses succeeded in shooting down approximately one in 10 attacking aircraft carrying conventional bombs. As a result, German air force units were reduced by factor of three after flying 10 attacking sorties [2]. London stood, although it suffered badly. This city would not have survived a single thermonuclear warhead. Thus, the standard of defense has to be raised considerably.

Perhaps the most bizarre nuclear system ever developed by the US Army was a weapon with a variable yield between 0.01 to 1 k ton TNT, that could be launched by either a 120-millimeter or a 150 millimeter recoilless rifle with a range of 2 to 4 kilometers [17].

The two-type classification of nuclear weapons according to their transport system appears to the author to be unjustifiable and, therefore, undesirable.

Already prior to the conclusion of the INF treaty a shift away from land- and air-based towards submarine launched long-range (strategic) missiles became evident in western NWSs, however was hailed less in the former USSR for obvious strategic reasons.

Problems with still existing short-range missiles as carrier of nuclear warheads should not be underestimated. The MTCR limits their range to <300 km, and the payload to

<500 kg. For instance, the German V2 exceeded the MTCR limit in payload by a factor of two and matched the rang limit. Complete blueprints for the Jupiter intermediate range missile of the 1950s (2,400 km range, payload about 1 ton) were contained on more than 500 reels of microfilm, and could be bought for about $11.50 per reel [18]. Basic knowledge of building this king of missiles is wide-spread.

At present, 19 developing countries possess intermediate or shorter-range ballistic missiles, but only a handful have the indigenous capability to produce them or to provide for their maintenance. Of these, only four- India, Israel, North Korea, and Pakistan – have produced or flight tested missiles with ranges over 1,000 kilometers [19] and could equip them with nuclear warheads.

Sophisticated and high performance transport systems are no longer necessary for terrorists or rogue countries, since modern weapons with yields of a few ktons TNT can be transported easily in a suitcase or by boat to any target due to their compactness and small weight.

It makes little military sense to transport chemical weapons with missiles over large distances. Their use is predominantly on the battlefield, delivered with short range guns, as was shown in WW I and the Iran-Iraq war. Powerful explosions of the weapon at high altitude over a target, to obtain a wide area coverage, army destroy the chemicals before they reach ground. Biological agents are even more sensitive to heat, so the distribution over a large area is an even more demanding task. There is an additional disadvantage of biological weapons: on the battlefield they may become effective only after several days with unpredictable efficiency, hurting possibly the own troops.

The Cost of the Nuclear Arms Race

The total cost for the U.S. Nuclear Weapons program from 1940-1996 was $5,821 trillion according to a final study by the Brookings Institution [17]. Strategic nuclear weapon systems need an enormous infrastructure, as can be seen from the breakdown of cost:

1)	Building the bomb	$ 409 billion
2)	Delivering the bomb	$ 3,241 billion
3)	Command, control	$ 831 billion
4)	Defense against the bomb	$ 937 billion
5)	Retiring and dismantling the bomb	$ 15 billion
6)	Legacies/nuclear waste from the bomb	$ 365 billion
7)	Managing/dismantling the bomb	$ 31 billion

The **cost** of producing (and maintaining in operational state" nuclear weapons are high. They peaked in the USA from 1983-1993 at almost $8 b/year, and stabilize now at $4 b/year for the US Stockpile Stewardship program [6]. The costs for the former USSR at the height of the Cold War may have been at a similar, if not higher level, but are now drastically reduced due to the economic breakdown of the country.

MORE TREATIES NEEDED?

Any treaty must be based necessarily foremost on trust, but also contain the provisions for verification. There have been decades of mistrust between the two super powers. Therefore, it is not surprising that the partners of treaties on NWs, BWs and CWs are built on items they believe are easiest to verify. Missile bases, heavy bombers, and submarines can not be hidden forever, cheating would bacome obvious. The time seems not yet to be right for the NWSs to go to the very root of the problem, namely the dismantling/destruction of warhead, including the complete elimination of weapon-grade fissile material and of tritium,

Some tentative suggestions are now made how to make more substantial progress in nuclear disarmament.

Fissile materials have dual use, in weapons (including peaceful explosions of nuclear devices, now mostly considered to be financially and environmentally ineffective) **and** in civil power reactors. As long as the uranium isotope 235 is not highly enriched, and plutonium isotope 239 is not sufficiently separated from its other isotopes, both materials are considered to be of less value for the declared NWSs, but are already interesting for would be NWSs. The enrichment and separation processes for these materials are complicated, expensive and time-consuming.

The conclusion of a **F**issile **M**aterial **C**ut-off **T**reaty **(FMCT)** [20], already proposed long time ago and now under more serious discussion at the **c**onference of **d**isarmament in Geneva **(CD)**, would be highly desirable, but is not sufficient by itself. Would-be NWSs can obtain clandestinely enough material from the enormous stock of weapon-grade material. Furthermore, most of the industrialized countries have the knowledge (and raw material from their power reactors) to produce nuclear weapons within a couple of years or even within a few months. Safeguard provisions by the **I**nternational **A**tomic **E**nergy **A**gency **(IAEA)** are not yet a guarantee for correct accountancy. Reactor-grade plutonium is available in abundance and can be used for weapons, albeit requiring some redesign of the warheads, and having not the same explosive power of a weapon with the same amount of weapon-grade plutonium. The IAEA has to be reinforced financially and politically.

The **production of tritium** and **lithium-6** for military purposes should be halted [14, 15, 16]. The total stockpile of tritium in the US, estimated at the end of 1993 to about 70 kg, is still sufficient for at least a decade to keep the yield of US weapons at present level. Russia as a similar quantity in storage and inside their weapons.

Removing the tritium from boosted weapons [14] of the first generation (containing ~2-3 g/warhead) would reduce their explosive yield by a factor 2 to 10, of thermonuclear warheads (~2-3 g/warhead) by two to three orders of magnitude. Only the small number of neutron bombs (enhanced radiation weapon) need 10-30 g/warhead. The hydrogen bomb is based mainly on breeding of tritium from LiD. The yield of the present arsenal, equivalent to the explosion of 750,000 Hiroshima bombs, would shrink dramatically by removing its tritium. Some of the weapons even would no longer function at all if tritium is removed from the neutron generator. Such a bold step in disarmament was never seriously discussed and may remain utopia for reasons, which are discussed in great detail in [14]. Verification would be close to impossible, since it would clear the way to learn design details of the weapons of the adversary, which are kept top secret.

Missiles have dual-use. They can be used to put communication satellites into orbit, for geological survey, for weather forecast, etc. The **MTCR** is not legally binding, and should be reviewed as far as the no longer sufficient payload limit of 500 kg is concerned. Nuclear weapons with explosive power similar to the Hiroshima bomb can be built with considerably less weight.

The **START** treaties aim at reducing operational nuclear weapons, have a too long lead time, and are not cutting the arsenal drastically enough. The ratification of START II by the Duma is long overdue and START III is urgently needed. The inclusion in the disarmament negotiations of the other three declared NWSs, China, France, UK **plus** the now de-facto states India and Pakistan, as well as Israel, is imperative.

Verification of treaties is a problematic and important area, too vast to be discussed in the present context. Verification has to go along with trust.

The further extension of **nuclear-weapon-free-zones (NWFZ)** treaties into industrialized countries should become an immediate goal in making our planet a safer place for everybody. Presently almost one-half of the globe – mainly the southern hemisphere – and nearly one-fourth of the world's population are covered by such treaties, which guarantee the non-weapon status of countries in the zones and forbid the presence of nuclear weapons. Negotiations are underway to create another zone in Central-Asia, reaching from Mongolia to the Caucasus. Respect of the rules by the NWSs is guaranteed on paper, but adherence is difficult to proof in reality, in particular at sea for submarines.

The strict and honest **adherence to existing treaties**, following their spirit (e.g. Article VI of the NPT), could be sufficient to put an end to the nuclear arms race and lead the way to the ultimate elimination of these weapons. Nevertheless, it should be complemented by a **Nuclear Weapons Convention (NWC)**, written as an extensive draft version by the Lawyers' Committee on Nuclear Policy [21], and had been distributed to the members of the UN General Assembly in 1997.

The US, the only remaining super-power after the end of the Cold War, could give an positive example by eliminating its arsenal on a time-based frame, then probably/possibly (?) followed by other NWSs, which could lead to a world free of nuclear weapons. However, present indicators of US policy point in the opposite direction [9].

The time has come to **aim simultaneously for fissile material cut-off, efficient missile control, nuclear weapons destruction, general disarmament and verification, i.e. to put all these items under one negotiation umbrella.** Ideally, such a comprehensive approach should be acceptable to all parties, rather than the continuation by piecemeal, wasting precious time, money, and efforts.

The suggested comprehensive negotiation may not be sufficient along for solving the nuclear weapon problem, as long as we have not **changed the mind of people**, have educated them that any war, in particular the one using nuclear arms, can not be fought, and is not an acceptable, profitable solution of problems, for any country, continent or the entire planet. The message has to come through that the possession of nuclear weapons alone is a threat to survival of mankind, since an accidental launch of a single nuclear weapon can trigger an all-out war, resulting in Armageddon. An enormous number of nuclear warheads are still on alert around the clock. Their control depends on reliable communication system: be aware of the **year-2000 computer problem!**

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