A VERIFIABLE FISSILE–MATERIAL TREATY AS A FOUNDATION FOR NUCLEAR DISARMAMENT

Discussion held April 11, 2007 at United Nations Headquarters by the NGO Committee for Disarmament, Peace and Security, in cooperation with the UN Office for Disarmament Affairs.

John Burroughs, Moderator, Lawyers Committee on Nuclear Policy
Zia Mian, Program on Science and Global Security, Princeton University, and International Panel on Fissile Materials
Frank von Hippel, Co-Chair, International Panel on Fissile Materials and Professor of Public and International Affairs, Princeton University

John Burroughs: I am the Executive Director of the Lawyers Committee on Nuclear Policy. I am here just to introduce the speakers and to help field questions in the discussion afterwards.

The topic today is A Verifiable Fissile-Material Treaty as a Foundation for Nuclear Disarmament. Zia will speak first and then Frank. Zia is a research scientist at Princeton University's Program on Science and Global Security. He has a Ph.D. in nuclear physics. He is director of its project on peace and security in South Asia. He has written very widely. He co-edited *Out of the Nuclear Shadow* in 2002. He is involved with the International Panel on Fissile Materials.

Professor Frank von Hippel is a professor of Public and International Affairs at Princeton University. He is faculty for the program on Science and Global Security. He is Co-Chair of the International Panel on Fissile Materials. In the 1990s he served in the White House office of the Presidential Science Adviser and he has had a distinguished career in the field of public policy relating to nuclear weapons. Before Zia embarks on his presentation, Frank von Hippel will say something about the International Panel on Fissile Materials.

Frank von Hippel: The International Panel on Fissile Materials is a panel of independent arms control and disarmament analysts from fifteen countries. It is funded by the MacArthur Foundation. We have been in existence for about a year now. We have a web site – www. fissilematerials.org - on which you can find our reports. One of our reports is the annual report which gives an overview and perspective on fissile materials, i.e., nuclear weapon materials, which are the common denominator for disarmament, non-proliferation and prevention of nuclear terrorism. We describe how much fissile material there is in the world, the various purposes to which it is put, and discuss some ongoing and possible initiatives to reduce the amount of this material, both in weapons and outside weapons, and the number of locations where it can be found.

We also have produced three topical reports. The first one, co-authored by Zia Mian, was on the US/India deal, and about the implications of that deal in terms of the fuel that it could put into the nuclear arms race in South Asia. The second one was about Japan's new and very large reprocessing plant, which is beginning to increase the world's already very large and dangerous

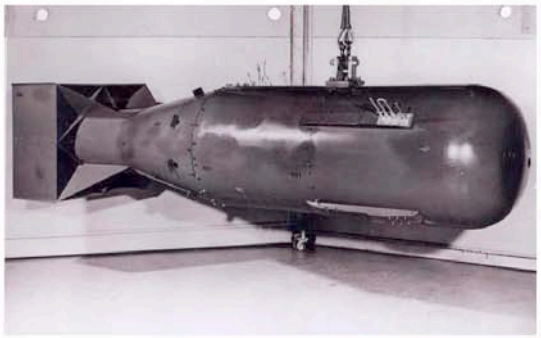
stock of separated plutonium. The third one is about the debate within the US on the same issue of whether the US should reprocess or not.

We have been working on the Fissile Materials Cut-off Treaty (FMCT). We gave a briefing at the CD last May, and we are developing a proposed draft treaty but also, more importantly, given who we are, an in-depth analysis of the verification issues associated with the treaty. Our talk today is an overview of these issues, the context and the verification of an FMCT.

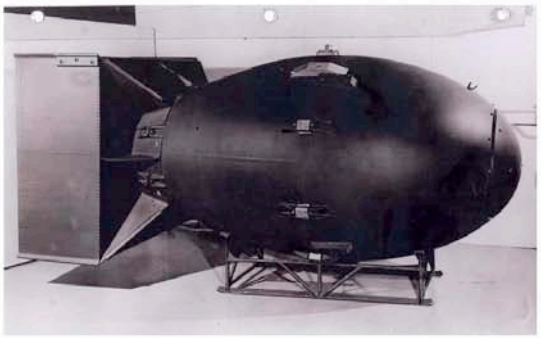
Zia Mian: We will be relatively short in the presentations so that we can take as many questions from you as possible. I am going to talk about the question of a Fissile Material Cut-Off Treaty and what are some of the key questions around it, beginning with a discussion of fissile materials and stockpiles. We need to better understand that. Then Frank will talk about the question, if we do get a Fissile Material Cut-Off Treaty, what are the issues about making that treaty effectively verifiable in a meaningful way, and what are the disputes about that.

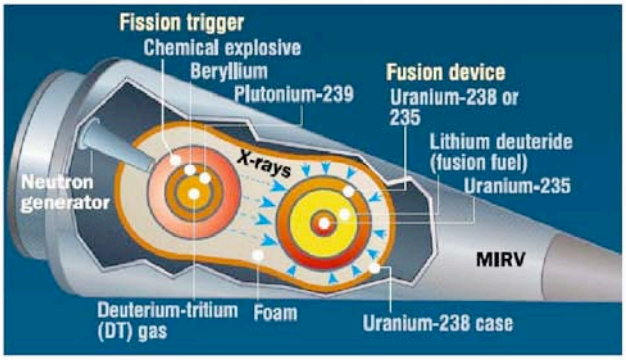
Figure 1. **HEU and plutonium are the most difficult to obtain materials in nuclear weapons**

Little Boy (Hiroshima)
60 kg HEU (~80% enriched in U-235)



Fat Man (Nagasaki)
6 kg Plutonium





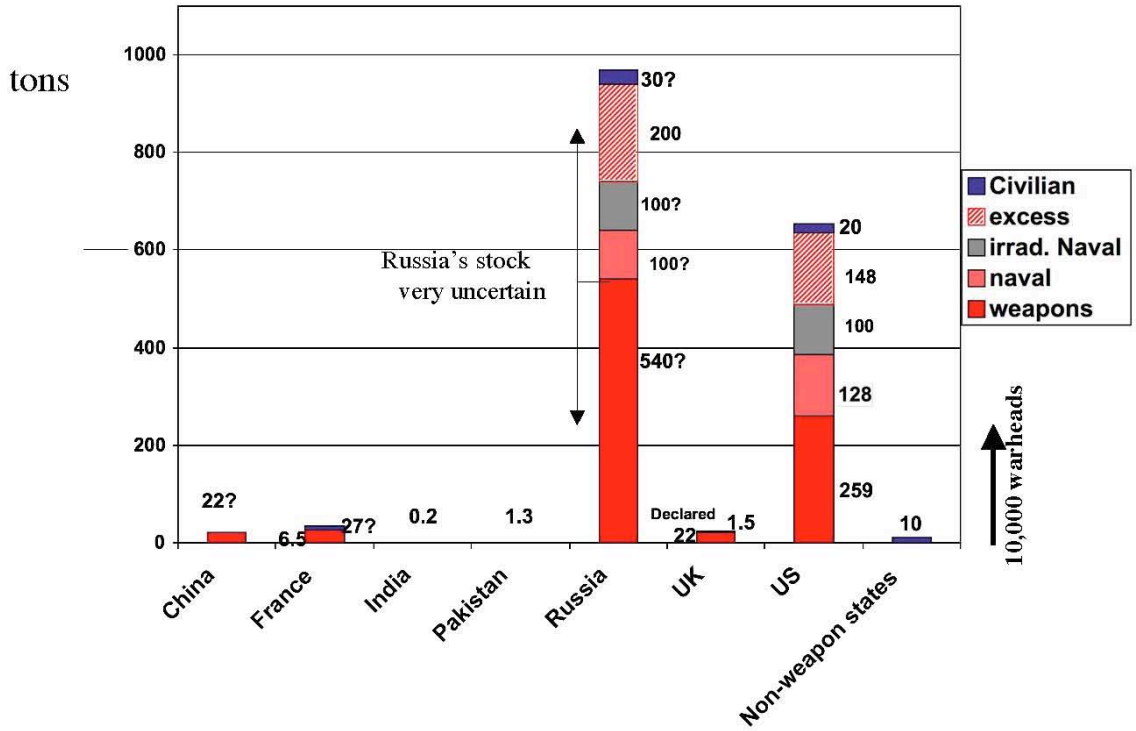
Modern two-stage thermonuclear weapon
≈ 4 kg plutonium and
25 kg HEU (average)

As I am sure you all know, what we are talking about here is Highly Enriched Uranium (HEU) and plutonium, which are the key ingredients for nuclear weapons. The Hiroshima bomb used 60 kilograms of Highly Enriched Uranium. The enrichment refers to the proportion of the isotope Uranium 235 in the material. The Hiroshima bomb used HEU that was 80 percent U 235,

but anything above 20 percent U235 is defined as Highly Enriched Uranium and can be used to make a nuclear weapon. The higher the degree of enrichment of U235 the smaller the amount of the material you need to make a weapon, although there is a limit on how small it can be.

The Nagasaki weapon used plutonium, which is the other major fissile material and is now the fissile material of choice in nuclear weapons. At the bottom of Figure 1 we have a representation of a modern thermonuclear weapon, which is the kind of weapon that is in the arsenals of most of the nuclear –armed states, especially the five nuclear-armed states of the NPT (Non Proliferation Treaty). You can see there that it has two stages, the primary, which is like the weapon that was used at Nagasaki and has plutonium as the key fissile material, and that the secondary, which is where the thermonuclear energy is released, (typically called the hydrogen bomb) includes Highly Enriched Uranium. Modern thermonuclear weapons use both Highly Enriched Uranium and plutonium, rather than exclusively using one or the other. Some of the new nuclear-armed states, for example Pakistan or North Korea, may have weapons that use only one or the other material. In the typical weapons that are in the arsenals of the more advanced nuclear-weapon states, these two stages contain on average about 4 kilograms of plutonium and about 25 kilograms of Highly Enriched Uranium.

Figure 2. **HEU Stocks: almost all Cold War legacy**
(500 t Russian, 234 t US) declared excess & being blended down.
Pakistan still producing for weapons.



Turning to the Highly Enriched Uranium, and who has what: During the Cold War, the United States and the Soviet Union engaged in massive overproduction of Highly Enriched Uranium, in part because no one seems to have told them when to stop, and so the huge amounts of Highly Enriched Uranium that exist in the world, over a thousand tons, is almost all in the stockpiles of Russia and the United States. Figure 2 shows our current best estimate of Highly Enriched Uranium stocks.

The NPT nuclear-weapon states, the United States, Russia, the UK, France and China, have all stopped producing Highly Enriched Uranium and Plutonium for their weapons. Four of them have made an explicit public statement that they have ended this production. China has indicated informally that it has ended production of fissile material for weapons. Israel, India, Pakistan continue to produce, and the status of North Korea is not clear. In the case of Highly Enriched Uranium, it looks like Pakistan is now perhaps the only country still producing Highly Enriched Uranium for its nuclear weapons. Ending the production of Highly Enriched Uranium for nuclear weapons is not going to be a major constraint for existing nuclear-armed states. For most of them it will be simply formalizing what they have already done.

Figure 2 highlights the uncertainty in some of these stockpile numbers. You can see question marks over China, France, and especially Russia where there is a very large uncertainty.

The US and the UK have declared how much Highly Enriched Uranium they have produced for their weapons programs. The others have not. The figure also tries to show the different ways in which this material is being used, so you can see the largest proportion of material is weapons, but there is a substantial amount, hundreds of tons, that is marked as naval. The United States, the UK, and Russia use Highly Enriched Uranium for nuclear propulsion for submarines and, in the case of the United States, aircraft carriers, and in the case of Russia, also for ice breakers. So there is a large amount of Highly Enriched Uranium that has been assigned to naval propulsion purposes. Some of it is set aside as a reserve for future use. Some of it is already being used, and we have tried to separate those two out. And then there is material that has been declared as excess to military needs.

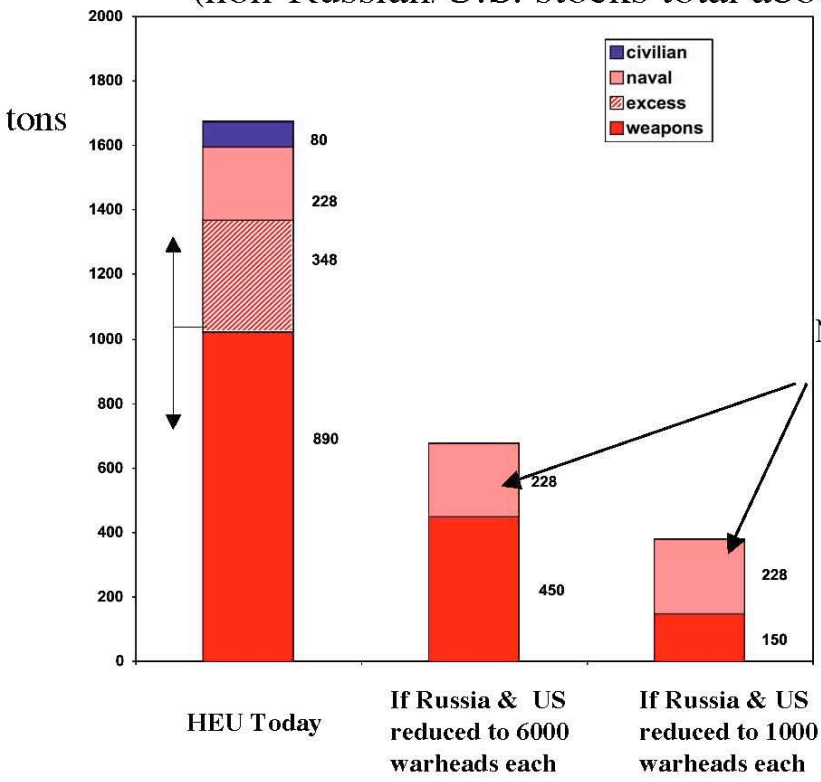
There is also the civilian use of Highly Enriched Uranium, which is significant. It takes only 25 kilograms to make a weapon. Here we are talking about tens of tons of this material that is in civilian stocks, being used mostly to fuel research reactors.

If we think about the question of how this is tied to disarmament, it is easy to see that, if Russia and the United States reduced their present arsenals, which are of the order of ten thousand weapons each, down to six thousand, a lot less Highly Enriched Uranium would be needed by both of them for their weapons. Figure 3 shows that if they reduced down to a thousand warheads each, which is a reasonable next step considering that as part of the Moscow Treaty they have already agreed to reduce down to about two thousand warheads deployed by 2012, the amount of Highly Enriched Uranium for weapons would come down dramatically.

But then this raises the question of the very large stockpiles of weapons useable material that has been set aside for naval use. How secure and sustainable would a Fissile Material Cut-

Figure 3. **Global HEU stocks: What if Russian/U.S. military stocks reflected warhead reductions?**

(non-Russian/U.S. stocks total about 90 tons)



Naval stocks are a growing complication. Could U.S., Russia & U.K. shift to LEU fuel like France?

Off be and what kind of extra conditions would be required to deal with the fact that there would be these large stockpiles of potentially weapons-useable material that are military, in the sense that they are assigned for naval purposes in nuclear navies but are not actually in weapons.

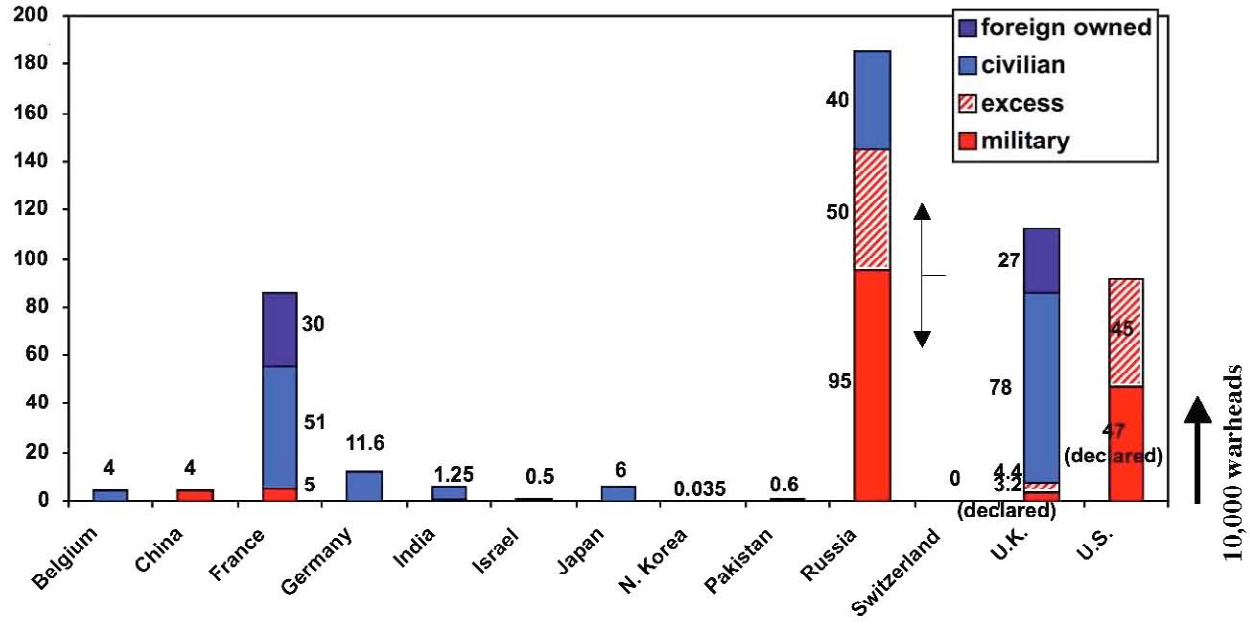
France has already moved to using low-enriched uranium to fuel its submarines. This can't be used to make nuclear weapons without further enrichment. One possibility would be that if Russia, the US and the UK are going to insist on continuing to use nuclear-powered submarines for carrying missiles to deliver nuclear weapons, they could shift away from Highly Enriched Uranium to low-enriched uranium fuel and therefore get rid of this problem of having a large stockpile of military HEU outside weapons.

The other fissile material is plutonium and it only takes a few kilograms of plutonium to make a nuclear weapon. The nuclear-weapon states in the NPT have stopped producing plutonium for nuclear weapons. Some of them continue to produce plutonium for civilian nuclear activities. Some non-nuclear weapon states also have stockpiles of plutonium. In the case of Japan in particular, there is a large civilian reprocessing program. Figure 4 shows the stockpiles. Once again, there is uncertainty, especially in the case of Russia. Though the military stockpiles are large, in some cases the civilian stockpiles are almost comparable to the military stockpiles.

If we are going to talk about a Fissile Material Cut-off Treaty that grapples with the question of plutonium for weapons, then what are we going to do about the large stocks of civilian plutonium?

Figure 4. **Separated plutonium: Half is civilian**

(Mostly in Russia, U.K, France and US.
India, Israel, Pakistan and DPRK still producing for weapons.)



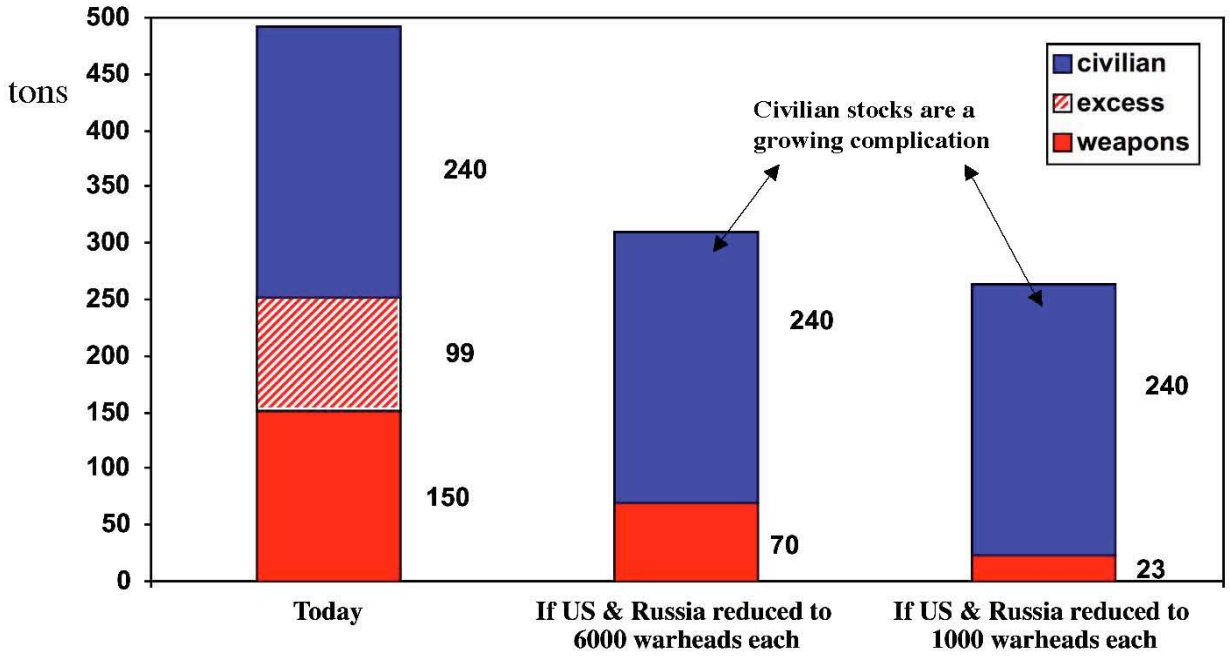
The civil plutonium in non-nuclear weapons states is safeguarded by the IAEA, but there is separated "civil" plutonium in the nuclear weapon states. What happens to these stockpiles? If you add the plutonium in the different categories, you see that there is about 150 tons of plutonium in weapons. The US and Russia have declared about 100 tons as excess to their military needs, although they are having a bit of a problem deciding what to do with it and how to dispose of it. If they reduced down to six thousand warheads each (Figure 5) the civilian stock becomes by far the largest proportion of the global plutonium stock, and by the time we get down to a thousand warheads each the civil stockpile is 10 times the military stock. A major question is how to manage this stockpile in a way that is transparent and safe and to make sure that it can't be diverted to nuclear weapons programs.

An immediate issue we have, in terms of the global stocks, and as part of a discussion about a fissile material cut-off and questions of verification, is that we need to get a better handle on who has how much fissile material in the world. And the key states of course are the nuclear weapon states. The US and the UK have declared their stocks but the others have not.

The Russian situation is particularly acute because the estimate of the uncertainty in its stocks is very large: +/- 300 metric tons of HEU, and +/- 25 metric tons of plutonium. Given that the US and the UK declared and nothing terrible happened, it is hard to understand why Russia has not been more forthcoming in declaring the production history of its Highly Enriched Uranium and its plutonium, what its current stocks are and its plans for managing them.

Figure 5. **Global plutonium: Potential for reductions**

non-Russian/U.S. weapon stocks about 13 tons



Unlike the other NPT nuclear weapon states, China hasn't formally declared that it has stopped production of fissile material for weapons but has indicated informally that it has. Since all the production stops are unilateral moratoria it is hard to understand why China could not formally declare that it has stopped and make that not just the norm among the nuclear weapon states but a kind of universal principle. The NPT nuclear states example could then be involved in a discussion with the nuclear weapon states outside the NPT (Israel, India and Pakistan). If they expect to have any kind of recognition as nuclear weapon states they should start to meet the norm applied to the other nuclear weapon states, which is to end the production of fissile materials for weapons as a way to begin the disarmament process.

There are multiple reasons why transparency in the production and stocks of Highly Enriched Uranium and plutonium is important. The US and the UK have gone through the process of trying to account for their stocks and in the process they have generated some important and very relevant insights into why this transparency is important for disarmament, but also for responsibly managing this material.

In the case of the US, it took a Freedom of Information Act appeal to get the US Highly Enriched Uranium balance released. The Bush Administration had been sitting on it and decided it would remain secret, but did eventually release it. One of the things that the US said about its 2001 report on HEU production and stocks was that it would serve "to facilitate discussion of HEU storage, safety and security [and] for formulating policies involving the identification and disposition of surplus nuclear material." This process of accounting for how much is being produced and how it was used, helps clarify the baseline for domestic policies and management: how to store it, how to secure it, and how to identify and dispose of material that you decide is surplus. It is only when you know what you have made, where it is, and what it was for, that you can start to account for it and to grapple with the question of managing it for the long term in a transparent way.

In its HEU declaration, the UK made an explicit connection to the nuclear disarmament process. The UK said that "transparency about fissile material acquisition for defence purposes will be necessary if nuclear disarmament is to be achieved; since achieving that goal will depend on building confidence that any figures declared for defence stockpiles of fissile material are consistent with past acquisition and use." This is a principle that I think many people share and it has been part of the understanding about nuclear disarmament for a very long time. The call for a fissile material cut-off treaty is many decades old now. It was seen, along with the Test Ban, as contributing to ending the arms race and furthering the process of nuclear disarmament, which was a commitment of the NPT under Article VI.

Also, as the UK declared, you need to have confidence that everybody knows how much material was produced and how it was used and what the stockpiles are in the process of disarmament to lay to rest any concerns about secret stockpiles. These transparency processes would aid an FMCT, but they have importance in their own right. As the British tried to go through their accounting they found that the records were decades old and had not been kept properly, because no one anticipated ever getting to this point

The British discovered that where they had records, it was sometimes difficult to reconstruct the production record. In some cases they didn't accurately record how much had been made. All of this suggests this is an important exercise for countries with weapons useable material is to go through and make sure that at least they understand properly what they have. And once they have done that, to share the results with the international community in a way that is useful and practical and contributes to the disarmament process.

The FMCT is an old treaty proposal, as I am sure many of you know. We have been involved in this process for decades. When the General Assembly dealt with this question in 1993, it said that it saw an FMCT as being a "non-discriminatory, multilateral and internationally and effectively verifiable treaty banning the production of fissile material for nuclear weapons or other nuclear explosive devices." This became the basis for the negotiating mandate that was sent to the Conference on Disarmament.

The NPT Review Conference in 2000 also took the position that the FMCT should be "a non-discriminatory, multilateral and internationally and effectively verifiable treaty banning the

production of fissile material for nuclear weapons…taking into consideration both nuclear disarmament and nuclear non-proliferation objectives." It is not just enough to have a treaty that says we will have no future production of weapons-useable material. That serves a non-proliferation objective only. What we need to have is a treaty that captures the NPT commitment to nuclear disarmament in a meaningful way.

At the Conference on Disarmament, efforts are underway to try and begin the process of negotiation, which has been stuck for a long time. In the meantime the US has shifted its position and no longer supports a verifiable FMCT. As a consequence the CD is considering a draft decision that it would begin talks on a "non-discriminatory and multinational treaty banning the production of fissile material for nuclear weapons or other nuclear explosive devices." The question of verifiability, the requirement that the treaty be verifiable, has been left open. This is a challenge: what does this mean for an FMCT and how to proceed?

We can imagine a minimalist FMCT. It could, for example, require that all the civilian activities in the nuclear weapons states should be subject to safeguards by the International Atomic Energy Agency (IAEA). This addresses the question of it not being discriminatory. These are civilian activities and since the goal of the treaty is to ban the production of fissile material for weapons purposes there is no reason why civilian activities should not be subject to IAEA safeguards.

The nuclear weapons states have given to the IAEA lists of facilities that they have volunteered for safeguards, but they are not all the civilian nuclear facilities, and the IAEA doesn't safeguard most of them. But we need the principle to be established in a treaty that all civil fissile materials will be subject to safeguards. This of course leaves the military fissile materials and the facilities that are specifically military and have fissile materials to be dealt with.

The second issue is that as the US and Russia, and the other nuclear weapon states declare more and more fissile material excess for weapons purposes as part of the nuclear disarmament process. Then this material should be subject to a safeguarding process. The IAEA assisted the United States and Russia to develop a trilateral set of safeguards. These could cover material that is being declared excess while it is still in classified form, in other words in the shape of weapons components and so on. Once it has been transformed into material that is no longer considered relevant to national security, then it should be handed over to normal IAEA safeguards. This should be a one-way door. It would make nuclear reductions irreversible, and also promote the principle of a non-discriminatory FMCT.

That leaves the question of the HEU being set aside for naval reactors and it may be that some states will seek to produce HEU for naval reactors in the future, after an FMCT comes into force. We need to find a mechanism that makes sure that this material that can be used for weapons is not used for weapons.

Now Frank von Hippel will discuss the verification issues that would be associated with trying to meet some of these requirements.

Frank von Hippel: I will start with a quote from the US presentation at the Conference on Disarmament on 17 May 2006. The US said "Effective verification of an FMCT cannot be achieved…even with verification mechanisms and provisions…so extensive that they could compromise the core national security interests of key signatories, and so costly that many countries will be hesitant to accept them."

This is a very different position from the position of the Clinton Administration. When I was working on these issues in the Clinton White House, our conception was that it was going to be a verifiable treaty. It is possible that the next US Administration will again become more positive about verification.

Let me walk through the challenges to verification.

1. You have to verify that facilities that have been used to produce highly enriched uranium or plutonium for weapons are shut down or converted to civilian use and placed under safeguards.

2. There is the same challenge that is already dealt with under the Non Proliferation Treaty for non-weapon states: verifying that civilian nuclear material is not diverted to weapon use. We know how to do that. It could be done with IAEA safeguards.

3. There is the problem of verifying that there is no production at clandestine sites. That too is a challenge that has had to be confronted in the non-weapon states by the IAEA. Most recently there has been a strengthening of the IAEA's abilities to detect clandestine production sites through the Additional Protocol. It is in force, however, only in the countries that have ratified it.

4. There is the special issue in the weapons states; to verify that there is no uranium enrichment or plutonium separation going on in nuclear-weapon or naval-fuel production facilities.

5. There is the challenge of monitoring excess weapons fissile material while it is still in classified form.

.

6. Finally, in countries having naval reactor fuel, how can we assure, given their sensitivity about intrusiveness, that none of their HEU is diverted to weapons purposes?

I will walk through these challenges one at a time.

Figure 6. **Cooling towers often tell if reactors are operating**
(Satellite image of plutonium-production reactors in Siberia, 2000)

Reactor on right is operating. That on left is not. Both to be permanently shut down in 2008.

Verifying that the production facilities are shut down is relatively straightforward and inexpensive to deal with. In fact, the US and Russia already have a bilateral agreement to verify that each other's plutonium production reactors are shut down. That task could easily be taken over by the IAEA. We NGOs can even verify the status of certain production facilities. Figure 6 shows as an example, a satellite image of a site where two plutonium production reactors are located in one building. The reactor on the right is operating while the one on the left is not. You can see that by the fact that vapor is coming out of the cooling tower associated with the one on the right. These are two of three production reactors in Russia that are still operating despite Russia's moratorium on the production of plutonium for weapons because they also provide heat for nearby populations. They produce weapon-grade plutonium as an unwanted byproduct of the heating system. Under the bilateral shutdown agreement the US monitors the containers holding the plutonium that is produced by these reactors to assure that it is not diverted to weapons use.

With regard to civilian facilities, a little known fact is that the IAEA is already verifying a large fraction of the world's uranium enrichment plants (see Figure 7). That is principally because the Hexapartite Agreement which was an agreement between Australia, Germany, Japan, the Netherlands, the UK and the US. The non-weapon states were sensitive about the intrusiveness of IAEA safeguards in their centrifuge enrichment facilities that might result in the loss of proprietary information. To reassure them the UK and the US said they we will also allow - in fact require - the IAEA to safeguard their uranium enrichment plants. So the UK enrichment plant is under IAEA safeguards. This has not been true in the US because it has not had centrifuge enrichment plants. Now that the US is replacing its gaseous diffusion enrichment

plants with centrifuge plants those centrifuge enrichment plants will also be subject to IAEA safeguards. France is also replacing its gaseous diffusion plant with a centrifuge plant that will, by agreement with the German-Netherlands-UK conglomerate, URENCO, which is supplying the technology, also be under IAEA safeguards.

Figure 7. **Verifying that civilian nuclear material is not diverted**

Could use same procedures as in non-weapon states. Many enrichment plants in the weapon states are already subject to IAEA monitoring. All civilian nuclear activities in France & UK are subject to Euratom monitoring.

Safeguards status of civilian enrichment plants in weapon states
(After Georges Besse I and U.S. Paducah GDPs are shutdown)

	Centrifuge Plant	**Subject to IAEA Monitoring?**
France	Georges Besse II	**Will be** (Hexapartite Agreement)
U.K.	Capenhurst	**Yes** (Hexapartite Agreement)
U.S.	Piketon, Ohio	**Will be** (Hexapartite Agreement)
	Eunice, NM	**Will be** (Hexapartite Agreement)
China	Shaanxi	**Yes** (China-Russia-IAEA agreement)
	Lanzhou 2	**Offered** (China-Russia-IAEA agree.)
Russia	Angarsk	**Offered** (international fuel center)
	3 others	No

Under a trilateral agreement between Russia, China and the IAEA, China has also offered its centrifuge enrichment plants, the technology for which was provided by Russia, to IAEA safeguards. IAEA safeguards are in force at one of China's facilities. Recently Russia has proposed to make one of its four enrichment plants an international plant and bring in the IAEA to safeguard it. So we are surprisingly pretty far down the road in the area of safeguarding enrichment plants in the weapons states.

The other key facilities are reprocessing plants where plutonium is separated. In France and the UK, the reprocessing facilities are subject to EURATOM verification. There are some storage facilities at each plant that are also subject to IAEA's safeguards because they contain materials from non-weapon states.

One tentative conclusion of the analysis that we have done so far is that the costs associated with FMCT monitoring of the civilian facilities in the weapon states may be much less than was estimated in the 1990s. At that time the IAEA estimated that it would cost about

$140 million a year, which was about one and a half times the IAEA's safeguards budget. Most of that cost was expected to be at reprocessing plants.

There are two problems with the IAEA's analysis of the cost of safeguarding reprocessing plants. One is that it was assuming 28 reprocessing plants. Most of these reprocessing plants were associated with weapons programs, however, and would be shut down under an FMCT. It would be very easy to verify that they were shut down.

That leaves today the 8-10 civilian reprocessing plants listed in Figure 8 - if you count all of India's reprocessing plants as civilian. The two UK reprocessing plants are to be shut down. The US is debating whether to reprocess. I think that the critics are winning that debate. I don't think we will ever build a new reprocessing facility. If we do, there will be 7 reprocessing plants in the world as seen in Figure 8 and not the 28 that was the basis of the IAEA assumption.

Figure 8. **Monitoring cost may be surprisingly low**

1995: IAEA estimated $140 million/year for comprehensive verification in nuclear weapon states. 60% of cost ($80+ million) was for **28 reprocessing plants**.

But military reprocessing plants would shut under an FMCT and U.K. plans to shut down its civilian plants around 2012.

6-7 civilian reprocessing plants in nuclear weapon states (assuming that U.K. shuts down its 2 plants)

China	1 pilot plant
France	2
India	1 military, 2 civilian?
Russia	1
U.S.	plans?

Without non-weapon-state requirement to detect diversion within 2 weeks, remote monitoring by IAEA and 12 short-notice one-week inspection visits a year could suffice **for remaining seven civilian reprocessing plants in nuclear weapon states,** costing a total of **$7 million/year -- about 6% of IAEA safeguards budget in 2005.**

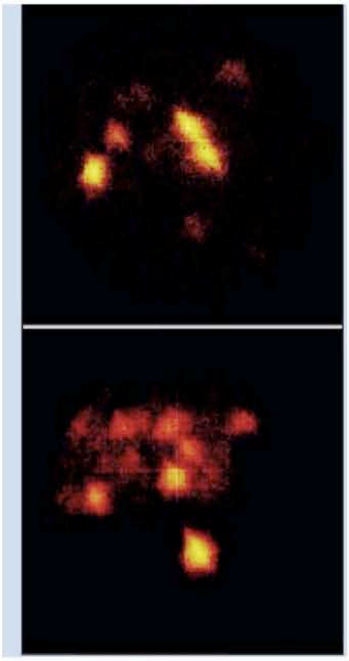
The cost issue has to be revisited in a transparent manner!

The other insight is that the high cost of monitoring the Japanese reprocessing plant at Rokkasho, about $12 million a year, need not be so high in the weapon states – initially at least. The cost is high in Japan in large part because a single nuclear weapon would turn Japan into a nuclear-weapon state. Operating at full capacity, enough plutonium to make 1000 nuclear weapons is separated in that facility annually. It is assumed it could be turned into a weapon

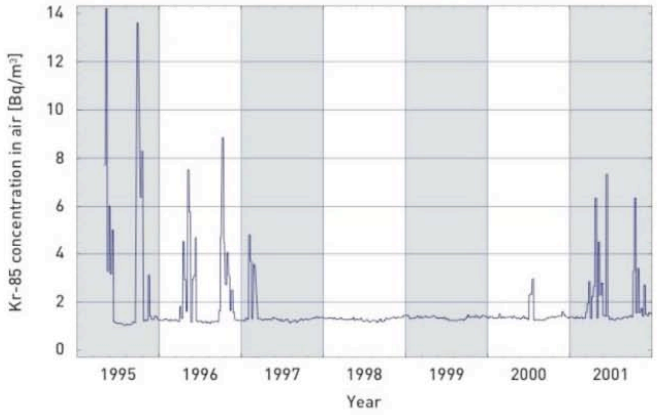
within two weeks. Therefore you basically need to have continual monitoring of the facility. For states that already have weapons, the stringency of this monitoring regime could be relaxed. We estimated that, if you relaxed it, you would not have to have the very expensive laboratory that the IAEA maintains at Rokkasho – and you would not have to have a team of inspectors there continually. Instead you could have one-week un-announced inspection visits 12 times a year and you could have the laboratory analysis done in Vienna. Our first estimate of the monitoring cost with these more relaxed requirements is one million dollars a year per reprocessing plant, rather than the $12 million per year cost of monitoring Rokkasho. So we are going down by about a factor of ten for this component of the monitoring cost.

Figure 9. **Detecting clandestine production**

(small centrifuge facilities are a challenge in both weapons and non-weapon states)



IAEA: Secondary ion mass spectrometry measures enrichment on particles collected in a swipe: Top: U-235; bottom: U-238



One-week average atmospheric Kr-85 concentrations measured at Tsukuba Japan, 1995-2001 (60 km from Japan's Tokai-mura pilot reprocessing plant). ***Production rate about 45 kg/week vs. ≈1 kg/week in DPRK.***

With regard to clandestine production, we don't have a silver bullet for the hardest problem, which is to detect a small centrifuge facility. But the IAEA has actually done pretty well in Iran ferreting out the history of Iran's enrichment program. A very powerful technique that was used is the so-called "swipe." You go into a suspect facility and you take a swipe of dust. Once you have done that, you can determine whether it is natural uranium or enriched uranium. The two pictures on the left side of Figure 9 show the same tiny area of a swipe. The top one is sensitive to the uranium 235. In the lower picture you are registering the U238 concentration. So, when you have a bright dot on the top image in a location that is dim on the bottom image, you know you have a particle of HEU. This is basically how the IAEA has been

operating, by going to suspect sites. It has surfaced much of the undeclared portion of Iran's enrichment program.

The graph on the right hand side of Figure 9 shows that you can detect reprocessing from a distance. When you reprocess spent fuel, one of the fission products is krypton 85, a radioactive but long-lived isotope that, like helium, is a gas that does not react chemically. It is released into the atmosphere by all the reprocessing plants in the world. Here you see at a monitoring station in Japan the detection of Kr85 from the Tokai pilot reprocessing plant 60 kilometers away, also in Japan. These are spikes over the background of krypton 85 that are about 45 times larger than rate of release from the Yong-bhong reprocessing plant in North Korea. If you were more than 60 kilometers away from the Yong-bhong plant, it would be less striking, but I think that the larger spikes would still be detectable.

These are techniques. No verification treaty is perfect. In the end, you have to do a cost benefit analysis. Is the verification system we can devise better than nothing? In my view, it is much better than nothing.

What I have been talking about is equally applicable to detecting possible clandestine facilities in non-weapon states under the NPT. It is basically the same challenge.

The Chemical Weapons Convention pioneered what would be done at military sites if you had a verified FMCT. It is called "managed access." When I was working in the White House I was very aware that there were studies going on of managed access at US nuclear-weapon facilities. It was at a time when the Chemical Weapons Convention was coming up for ratification. The Department of Energy was concerned about assuring that inspectors from the Organization for the Prohibition of Chemical Weapons (OPCW) who came into US nuclear weapons facilities would not take sensitive information away with them. It was concluded that the US could let OPCW inspectors in and shield the sensitive information in those facilities while at the same time satisfying the inspectors that the US was not producing nerve gas in them.

A similar analysis was begun during the Clinton Administration for an FMCT. The IAEA already has the right to request such inspections of military facilities in non-weapon states to determine whether there are any undeclared nuclear activities being carried out there. There is obviously nuclear material in a nuclear weapons facility but I think monitored inspections could be worked out to assure that there was no enrichment or reprocessing being carried out at such sites. For example, there is no reason for fission products to be present at a nuclear-weapon site. Such fission products could be an indicator of reprocessing activity.

The Trilateral Agreement between the IAEA, Russia and the US was initiated during the Clinton Administration when the US and Russia wanted to be able to demonstrate to the world that the fissile material they had declared excess from their weapons programs had been irreversibly put into the non-weapons domain. It is going to take a long time for the plutonium and the highly enriched uranium to be taken out of these weapons components. The question was: could the components be subject to some kind of IAEA monitoring while they contain sensitive design information? That is what the Trilateral Initiative was about. Later on both the

US and Russia walked away from this. They did not walk away, however, until after the negotiations had been basically completed for the plutonium-containing weapon components.

The US provided a plutonium weapons component in a container at a demonstration in Los Alamos, as shown in Figure 10, and showed that by using measurements both the gamma rays and neutrons coming out of the container, one could verify that the container contained at least two kilograms of weapons grade plutonium in metal form. There was additional classified information that one could derive from these measurements. They were therefore fed to a simple computer, and both sides had confirmed that it had behaved as it was supposed to behave. That filtered down to the questions of minimum quantity of plutonium, metal form and weapon isotopic grade into simple red or green, i.e., yes or no. I am convinced similar arrangements could be devised for HEU-containing components.

Figure 10. **Verifying that excess material in weapon components is not diverted to weapons use**

Trilateral (IAEA-Russia-U.S.) Initiative

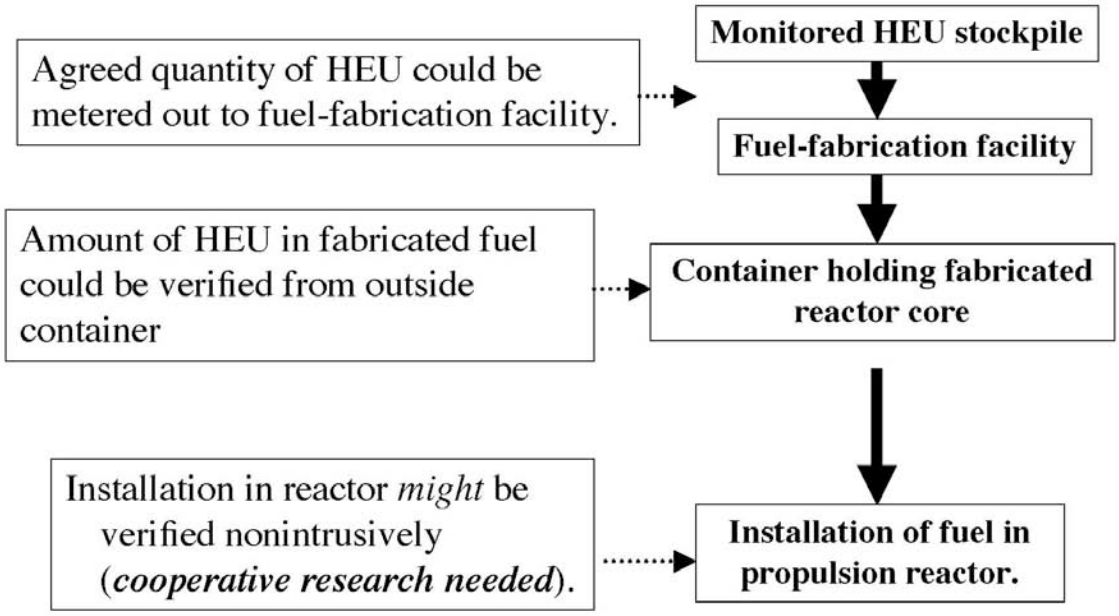
Nonintrusive verification with gamma plus neutron measurements that canister contains *at least 2 kilograms of weapon-grade plutonium metal.*

"Information barrier" protects classified mass, shape and exact isotopic mix.

Similar arrangements could be devised for HEU-containing components.

With regard to the monitoring of HEU in naval reactor fuel cycles, the US may be more sensitive than with the weapons components. At the moment the US has a stockpile of HEU for naval-reactor fuel that is enough for 50 to 100 years of consumption. We think that an FMCT should place that material under IAEA monitoring, but it could be kept out. In that case the issue would become that of verifying that newly produced material for naval reactors was not being diverted to weapons. The US Navy has a very long view, and is concerned about this issue.

Figure 11. **Verifying that naval HEU is not diverted**



Better solution would be for U.S., U.K. and Russian Navies to follow France's example and design future reactors to be fueled with LEU.

In Figure 11 there is an outline of how we might proceed. We assume that we start with a monitored stockpile of HEU - either the excess stockpile that exists now or HEU produced for naval purposes after an FMCT comes into force. The IAEA would measure how much HEU was being removed from this storage facility and being shipped to a fuel-fabrication facility. Then, after the fuel was fabricated and placed in a container, the inspectors could through radiation measurements determine how much HEU was in that container to see if it matched what went into the fabrication facility minus production losses, which could be monitored separately.

Then there would be the challenge of verifying that the fuel had actually been installed in the naval reactor. This would depend on the design details of the submarines or aircraft carriers and their reactors. Probably we can't solve this problem from the outside without cooperation from the weapons states.

As Zia mentioned, it would be much simpler if the US and the UK and Russia followed France's example and designed future reactors to be fueled with low enriched uranium, which is of much less concern. It would also remove the concern about a possible breakout use of all the HEU in those naval stockpiles for weapons.

Our overall conclusion is that we don't think the verification of an FMCT is of much greater difficulty than verifying the NPT. The task can be simplified to the extent that the FMCT can be made to look like the NPT so that we can take advantage of all the tools that have been developed for the NPT. Specifically, if materials in civilian facilities were put under the same type of monitoring, the difference between the nuclear weapons states and the non-nuclear weapons states would be localized to the nuclear weapon facilities and the naval reactor facilities. As disarmament shrinks the nuclear-weapon complexes, then the nuclear-weapon states would come to look more and more like non-nuclear-weapons states and the FMCT monitoring system would converge with the NPT monitoring system. We think that all this could be done at a reasonable cost.

One of the amazing things I learned when I was inside the US government, however, is how much more difficult it is to get money for the IAEA than it is to get money for the Defense Department. On an international security scale, even hundreds of millions of dollars a year would be tiny. FMCT monitoring could be much cheaper than that. Thank you.

John Burroughs: Thank you, both of you. Probably most people here know that there is a proposal under consideration now in the Conference on Disarmament for negotiations on a Fissile Materials Cut-off Treaty and substantive discussions on prevention of an arms race in outer space, and negative security assurances and nuclear disarmament. Perhaps this is a very timely presentation that we just heard. Let's have some questions and comments. I would like to take them first from the diplomats in the room or the UN staff in the room.

Ambassador to the CD, Bernard Brasack of Germany: I would like to mention that the work you are doing is very useful, always interesting and certainly all of us hope that in a time-fixed time we might be in a situation where we could start negotiating about this. The only draft proposal on the table is one put forward by the US. There are also a number of papers 10 years old and some of them newer. A very hypothetical question: If you had a choice, between adopting the US proposal as it is tomorrow evening, or nothing. Are we better off with something rather than nothing? For the time being we have only a moratorium, and not all are in this moratorium and they could easily withdraw for the moratorium. You might argue that what the US proposes is a sort of moratorium with some legally binding words.

On the other hand, you could also argue that once you adopt something like the US treaty proposal, you cannot easily revisit the issue of the FMCT. You have something that is in place for the foreseeable future. We have had this kind of discussion in Geneva, and it was my impression that none of the five NPT nuclear weapon states are particularly enthusiastic about the declaration and verification requirements.

We have four other nuclear weapon states outside the NPT and two of them are on the record pleading for verification. Pakistan says existing stocks should also be included, and India, it should not include existing stocks. And then we have Israel with its policy of ambiguity. That might be a problem. And then we have North Korea and the Six Party process which will also deal with some of these questions in the long room. For the non-nuclear weapons states it is this kind of attitude of the nuclear weapons states that makes this certainly an uphill battle.

If verification would not be feasible in the beginning, or if it would be very time-consuming, what would you think of a step-by-step process, as we had to some extent with the CTBT? First we had to pass the Limited Test Ban Treaty covering only atmospheric testing. But there was a legal requirement in that treaty to come as soon as possible with a comprehensive treaty. Could you think of something like that? All of us know that the Chemical Weapons Convention took from 1984 to 1992, eight years, to negotiate that one. It took another five years for that to enter into force. We are talking about 13 years. Would a more perfect FMCT in 13 years, would that be a bad choice, or should one have a gradual step-by-step process, first a moratorium, maybe then a legally binding decision about further requirements to be negotiated, firstly for example, a requirement for baseline-declarations about stocks, possibly without full verification requirements at the beginning, and in a third phase provide verification underpinnings?. These are the choices we have before us. Maybe you have some opinion about this.

Frank von Hippel: Your opinion is more sophisticated than mine. Certainly the step-by-step approach has a real appeal if one could capture all of the countries that are producing fissile materials for weapons and if one could not undercut the possibility of then moving on to a verified treaty. Under the leadership of Ambassador Meerburg, the IPFM is trying to draft an alternative FMCT in that way.

Ambassador Brasack: I would like to encourage the work that you do. It is very practical work. Solution (a), the middle one, (b) the more difficult one. We need a lot of choices in the text.

Frank von Hippel: I guess another precedent is the Climate Change Convention, which was a framework convention, and then implementing protocols were developed within the context it created.

Zia Mian: I'd only like to add that one of the lessons that we can learn from the history of the arms control process is that, if we are going to append these linkages to future agreements that it would be important to make a commitment to a time-bound process, rather than leave it open. We saw that the commitment under Article VI to negotiations in good faith on nuclear disarmament. It seems that negotiations can take forever just to start. Within the NPT there was a 25-year time limit. One imagines an FMCT evolving step-by-step, which as you say might begin with formalizing the moratorium, but which has a requirement to fix a time for the next step to be achieved, rather than saying, one day, sometime, perhaps. Rather, you have five years to go through the mechanisms to make sure you understand how you will deal with questions of managed access. So, in five years, come ready to negotiate the next step. Otherwise we may end up with what you described as a fear that we could get this but never get anything else.

Khalil Hashmi, Mission of Pakistan: I would like to thank all the panelists and Mr. Burroughs for providing us with this opportunity to participate in this briefing.

As I see it, the panelists have provided a very useful academic perspective on the issue of FMCT. My comment is more from a national security or a diplomatic perspective.

I would start with the title of the briefing, an FMCT as a Foundation for Nuclear Disarmament. Frankly, from my point of view, the way it has been projected it looks like an

FMCT as a basis to prevent proliferation. It is not about disarmament. The Cut-off itself would address only the non-proliferation part, and not the nuclear disarmament part. That is where the stockpile issue comes in.

I know these are very difficult questions and issues because they relate directly to the national security perception, priorities and policies of different countries. That is the reason you see that there are still thousands of weapons in the stockpiles of some States. Nuclear weapons are still there. So an FMCT, as long as it is going to be a Cut-off, would not address the stockpile issue. That is one element of it.

The other comment is in the form of a question and I will come to that shortly. As the US has said, it has concluded its own inter-agency review, and determined that FMCT is not verifiable.

That may well be their own point of view. Our view, and that is based on our own national security perceptions, is that the CD had an agreed mandate a verifiable FMCT. To change it now to a non-verifiable and to say that it should be accepted without any pre-condition, that is very difficult for other countries to accept. This in itself becomes a pre-condition that a verifiable mandate is not acceptable. If there is no verifiable FMCT, in simple words, it will constitute, as the Ambassador of Germany mentioned, a moratorium on the production of fissile material production. That is what it amounts to. You have a moratorium. You impose it. But how do you verify the moratorium? Is it to be verified through national technical means - while those national technical means are, at best, available with one country, or at maximum, two countries?

So these are the issues. One is that it amounts to a moratorium. The other is that the moratorium will be verified through national technical means. And the third issue, from our own region's point of view, and that it is essentially an issue of national security. If it is an issue of national security for the Permanent Five, it is so also for the rest of the countries. From our point of view, there is another element to it. When we see the US/India nuclear cooperation agreement, there is a consensus among the non-proliferation community, that the net result of that cooperation agreement would be the addition to the fissile material stocks of one country in South Asia. Where does it leave us? It would of course oblige us to respond. My question to you is, if you put yourself in our shoes, how would you address this issue?

Frank von Hippel: I think you are right on your three points. The FMCT does address production, but it also should have built into it, declarations of excess, and a requirement to place those materials under IAEA safeguards. And there should be pressure of course to declare more materials excess for weapons purposes. That is the reductions that Zia was talking about. It is certainly not, as we described it, a disarmament treaty where the amounts declared excess are negotiated. That is a legitimate criticism of it.

With regard to verification, I think the US has made clear that you don't have to take the US position on verification. They don't want it assumed that verification will be built into the treaty. They may lose that debate, I hope they do, or that a future administration changes the US position. I think almost any future US administration would. In that case, the negotiation would

be open to producing a verifiable treaty and I hope that will be what the result will be. That is what a major element of the negotiation would be about.

Regarding the US/India deal, I think you know we have written about our concern about that. It would be a much more palatable deal if there were condition in it that India would join the fissile moratorium and put all its facilities under safeguards.

Paolo Cuculi, Mission of Italy to the UN: …I am particularly glad to attend this seminar, as my senior colleague, Ambassador Trezza, is the coordinator at the Conference on Disarmament for the issue of fissile materials. I don't have particular questions on this issue, but rather a general consideration about the different options, having a FMCT immediately verifiable or not verifiable, and I think Professor von Hippel, you are the living demonstration of how things go in life and in diplomacy. For years the verification itself, related to disarmament and non-proliferation, in particular on a FMCT was a dialogue. I started my work in disarmament in 2000 negotiating a verification protocol for the BTWC, already an 8 year-old negotiation. Then one day we discovered that the consensus for verification applied to the BTWC was no longer there. Perhaps already you were not in the position you used to have. It is a fact of life that administrations change, they shift their views, and there may be an important shift in the consensus with a change of administration.

But as you said, consensus was there in the past and though missing now it could be back in a future that may not be that far, so the options are, do we want to continue to keep things stopped, waiting for this consensus to come back, or do we want to try to have a chance to start the process, because I don't think if the negotiating mandate is agreed today at the Conference on Disarmament, a Fissile Material Cut-off Treaty will be negotiated in a few weeks, or a few months, or even in a few years. Negotiating diplomatic experience shows it will take years, and in those years, the issue of verification could be put on the table, because a mandate saying negotiations will take place without preconditions basically does not preclude the possibility for delegations to raise the issue of verification. And the issue of verification is one of the key priorities for the European Union, if you take a look at our strategy on WMD non-proliferation of 2003.

So it is important, as we say in Italy, that the good soldier must think to survive for the next battle. My suggestion, if there is after more than 10 years a chance at the Conference on Disarmament to start negotiations on a FMCT let us seize it and there will be ample time for all delegations to raise all the issues they want, perhaps in a general environment which is less unfavorable to the issue of verification and other issues.

The issue of stockpiles is as important as the issue of verification. Now everybody pays attention to a verifiable or non-verifiable FMCT treaty. In our opinion, the issue of stocks is as important, if not more important. Again, it would be almost impossible to rule out negotiations on the issues of stocks since the beginning. There would be one important, if not the most important, aspect of the FMCT negotiations. The Shannon Mandate was an excellent one. It enjoyed consensus for some time. Apparently it doesn't enjoy consensus any longer. Let us try for negotiations without conditions as soon as possible. And we will have ample opportunity to bring back all our priorities. Thank you.

Khaled Shamaa, Mission of Egypt: First I would like to thank the panelists for a very informative presentation. I just have a few observations and a question. I will start with the question. What you have described here so far is an FMCT with verification. How would you imagine an FMCT without verification? What value would an FMCT without verification have?

If you would allow me, I just want to refer you to something that I am sure everyone is well aware of – which is step 3 of the 13 practical steps agreed in 2000 by consensus in the Final Document of the 2000 Review Conference of the states party to the NPT. It states clearly the necessity of negotiations in the Conference on Disarmament on a "non-discriminatory; multilateral and internationally and effectively verifiable treaty banning the production of fissile material for nuclear weapons or other nuclear explosive devices", in accordance with the statement of the Special Coordinator in 1995 and the mandate contained therein, taking into consideration both nuclear disarmament and non-proliferation objectives. The Conference on Disarmament is urged to agree on a program of work which includes the commencement of negotiations on such a treaty with a view to conclusion within five years.

There are two main problems. First, the approach of a take it or leave it option is an approach that frankly is not acceptable. Nothing is a take it or leave it scenario in multilateral negotiations. Multilateral negotiations is about reaching consensus, is about reaching an agreement. But a prescription that is presented to the international community; you have to take it or the window of opportunity would be lost, is something that is not exactly in favor. Therefore the idea that we have an opportunity now – either we take it or it is lost forever with regard to the FMCT is not exactly an issue. I would like to refer to what my dear friend Paolo from Italy was referring to now. Since he joined the Foreign Service the issue of verification has been problematic. It is problematic, and it is basically about a very simple concept. If all states agree to apply the same rules - it is basically about this. A verification system in the case of a FMCT or any other international instrument that deals with nuclear material and nuclear weapons should not be much of a problem because we already have the structure. We already have the agency. So it is not as if we are inventing a totally new structure that is nonexistent so far.

Now we come to the issue of the value-added of such a treaty. You said very clearly it is not a nuclear disarmament agreement. Well, if it is not a nuclear disarmament agreement, then it would actually be undermining the legal regime that we have currently, which is the nuclear Non Proliferation Treaty regime. If we are going against the purpose and principle of the NPT, going against the outcomes and the decisions and resolutions of the NPT Review Conferences, we are actually undermining the non-proliferation regime that came about through the treaty of the NPT and not building it up. So the end result would be a detrimental factor. Maybe for some the issue of verification would be problematic because it relates to intrusiveness. But if you do not have an intrusion, how would you be able to know if the treaty is being implemented or not, if there compliance by states parties with such a treaty when it comes into being? These are very basic elements that have to be taken into consideration.

Of course, the point of the step-by-step as referred to by Paolo, is quite valid. But the problem is, that can be a valid point if you don't have already a negotiating mandate that was agreed upon. Until there is another agreement on that mandate that took several years to be

negotiated, such a treaty would at best be detrimental to the current non-proliferation regime and not a helpful element, for one simple reason. It would actually legalize more the retention of nuclear weapons by the five nuclear weapons states party to the NPT and not advance the nuclear disarmament objectives and applications as per the NPT, let alone a new FMCT, with or without verification. So if this is the route that the international community wants to go about, undermining the legal regime that we have currently, we can consider that, we can look into that. But in terms of approach, a take it or leave it approach, that is actually more detrimental than the consensus building, and this has been tried several times before. Secondly, in our understanding, this is not an agreement reached through the Shannon mandate, this is a non-proliferation measure, and that is also detrimental to the NPT Review Conference results.

What value would such a treaty have and what would it look like without verification? Thank you.

Frank von Hippel: I think it is an overstatement that an FMCT undermines the NPT. It is part of the necessary infrastructure for disarmament. It is required for making disarmament irreversible, that you can't produce new materials for weapons. I may be wrong but I don't think that the proposed mandate rules out questions of stocks. It doesn't rule it in. It leaves that for discussion along with verification.

You asked what is the value of a FMCT without verification. I can imagine a step-by-step approach to verification. For me the first steps would be and should be fairly easy and valuable. One would be to put the civilian sectors and the civilian materials under monitoring. The other would be to verify that production facilities have been shut down. It is much less intrusive to verify a production facility has been shut down than to go in a nuclear-weapon or naval-fuel production facility and say we are looking for a possible clandestine centrifuge plant in one of the rooms. Consider, for example, Dimona. One could verify non-intrusively that it had been shut down. That could be one of the first elements of a step-by-step FMCT.

You could learn whether the reactor was turned off using satellite imaging at visible and infrared wavelengths. One could do additional things like set up kryption-85 detectors outside the fence to be satisfied that the underground reprocessing plant had been shut down.

Zia Mian: The title that we used wasn't the Fissile Material Treaty as a treaty for nuclear disarmament. I don't think we are trying to say this is the treaty that we have all been hoping for that would get rid of nuclear weapons. It is a foundation for nuclear disarmament in the same way that the Comprehensive Test Ban Treaty was supposed to be part of the basic infrastructure that allows the process of nuclear disarmament to actually develop and mature. If we didn't make this clear, that is what we meant.

The second thing is, I did quote from the NPT 2000 Review and tried to make exactly that point. For us, and I think for most people, it is important that this treaty be non-discriminatory and that, in the same way that there was agreement on the Shannon mandate, that perhaps should have explicitly included stocks, but then eventually people agreed that stocks can be raised. If now verification can be raised, then in the same way that people were willing to negotiate, even though they had insisted previously that stocks should be part of the mandate,

and were willing to go along with the Shannon mandate, then, for those who think that verification should be part of the treaty, it can be raised. I think the point was well made and is an important one.

With regard to the question you raised about what would be the value of a FMCT without verification – I think it is important to ask the question whether there is any value to any kind of political commitment? If you say it doesn't really matter what a state says, it is all a question of a treaty; then we have had the experience also with problematic treaties. We have seen the United States withdraw from the ABM treaty. We have seen the Senate refuse to ratify the Test Ban. We have seen North Korea withdraw from the NPT. And there are many more examples. I don't think that we can hinge everything on having a multilateral negotiating process that delivers just the treaty we want. Otherwise we won't want to be part of a process. We have seen this process unfolding in many ways. My question to you would be that a process of engagement and discussion and negotiation has a value, and political declarations by states also have value. The question the international community needs to ask itself, how to find mechanisms whereby these discussions are fruitful and enduring and non-discriminatory, rather than trying to pile on as much in advance that limits the process, so that, if we don't get what we want, nothing happens. That is an attitude that can be played from both ends and is not fruitful.

John Burroughs: Let me just add a couple of comments. I think we need to be quite clear that the treaty whose elements Frank and Zia talked about is extremely different than the draft text that was put forward by the United States. And with respect to stocks in particular, the proposal made here today is that excess materials would be put into a process and monitored, so that they could never again be used for weapons. There is nothing like that in the US draft proposal. All these things should not be combined together when they are quite different. It is true, as Frank said, that this would not require reductions of stocks. It would be nice to have a treaty that required reductions of stocks. I am in favor of it. That would be in essence a nuclear abolition treaty, which I do want.

I would just add one point about the important question of what can be done in the near term. I personally fear that, if there is agreement on a very limited scope Fissile Materials Treaty, it might not be changed or revisited for a very long time to come. We had that history with the Limited Test Ban Treaty. If there are other possibilities, for example, if there is a joint declaration of all the countries that have nuclear weapons that they are not going to produce material for weapons, and maybe they make some sort of invitation for limited verification by the IAEA, I think we should think about other possibilities for the short term moratorium than saying that is what the Fissile Materials Cut-off Treaty will be.

Alice Slater (Nuclear Age Peace Foundation): I think we have to be careful about this. It is good to figure out how we are going to verify. We have to look at ways to do that. But I look at the Comprehensive Test Ban Treaty, which had a loophole at the time it was negotiated, where India argued you are not cutting off computer simulations and technical laboratory virtual reality testing. Now the US is ready to produce new bombs without testing. I am hopeful that we will change our government so that there will be an opening. We need political pressure from governments that want to get rid of nuclear weapons. This Fissile Material Cut-off Treaty is like the Limited Test ban Treaty. You saw the inventory of the civil stocks.

I was at the CFD last year. We had a woman from Cairo, from the electric company who said that they could cover the desert with solar panels and power all of Egypt. I said why aren't you doing that? She said that the World Bank and the IMO will not lend the money for that. I think we have to really do jujitsu here, get away from this nuclear age. We have to look at the combination, nuclear power and nuclear weapons.

Nancy Colton, (International Association for Volunteer Effort): I think we need to simplify this process. Have a treaty for the nuclear weapon states to address the military build-down to elimination, such as the 13 steps, and also address their own civilian nuclear resources to build down that as well. And we need a treaty for the non-nuclear states as well to build down their processing of Highly Enriched Uranium and plutonium. We need more environmentally safer sources for energy.

Frank von Hippel: I would just like to clarify that International Panel on Fissile Materials is much broader than just the FMCT. Our agenda does include disarmament and it does include minimizing civilian stockpiles of plutonium and highly enriched uranium. We also show, for example, that the US and Russia could be declaring much more material excess. The US, for example intends to reduce to 6,000 warheads from the plateau of about 10,000 warheads where the US was when it was declaring excess materials in the 90s. So we could declare much more and so could Russia. By showing these facts we hope to lay the basis for putting more pressure on the US and Russia, for starters, and later on, on other countries to declare more excess and to use these declarations and the pledge to place these materials under international monitoring as a vehicle for irreversible disarmament.

John Burroughs: Thanks everybody, for coming.