

Disarmament

2007: Critical Disarmament Issues

*Panel discussions organized by the NGO Committee on Disarmament,
Peace and Security in cooperation with the Office for Disarmament Affairs
on 11, 12, 19 April and 19 October 2007*



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Note

This publication contains extensive excerpts from transcripts of meetings held at the United Nations in 2007 by the NGO Committee on Disarmament, Peace and Security, in cooperation with the Office for Disarmament Affairs, in the framework of the mandate of the United Nations Disarmament Information Programme (General Assembly resolution 61/95).

The Office for Disarmament Affairs is publishing the material as edited by the NGO Committee.

The views expressed herein are those of the participants and do not necessarily reflect those of the sponsoring bodies.

These transcripts are also available electronically at www.igc.org/disarm.

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Introduction

This publication includes the edited transcripts of four discussions held at the United Nations Headquarters, in April and October 2007, organized by the NGO Committee on Disarmament, Peace and Security, in cooperation with the UN Office for Disarmament Affairs. Three of the discussions focused on the feasibility of verification of a possible fissile material treaty and of the Biological Weapons Convention. The fourth presentation focused on the value of a code of conduct for outer space.

The presentation by Frank von Hippel and Zia Mian, on 11 April 2007, lays out the case for the feasibility of verifying a ban on the production of fissile materials for military purposes. The United States introduced to the Conference on Disarmament in 2006 a draft treaty to ban the production of fissile materials for military purposes, which has no verification protocol (document CD/1777 of 19 May 2006). The present United States Administration claims that such a treaty can not be verified. Hopefully the Conference on Disarmament in Geneva (CD) — the body that has negotiated other treaties, including the Chemical Weapons Convention and the Comprehensive Nuclear-Test-Ban Treaty (CTBT) — will succeed in 2008 in creating an ad hoc committee that will focus on negotiating such a treaty. Whether it should have a verification protocol will be one of the key issues. Another is whether the treaty will address stockpiles of existing fissile materials.

On 19 October 2007, Frank von Hippel and two other experts from Princeton University and the International Panel on Fissile Materials, Harold Feiveson and Alexander Glasser, presented parts of the 2007 Global Fissile Material Report. They focused on nuclear weapons and fissile material stockpiles and production, the disposition of excess highly enriched uranium (HEU) and excess plutonium (PL). They also focused on international safeguards in the nuclear-weapon States and on managing the civilian nuclear-fuel cycle.

Another presentation, on 12 April 2007, was made by Michael Krepon (Stimson Center). Many Member States of the United Nations have been advocating for the creation of new space law, and China and the Russian Federation have taken a lead in these efforts. The United States has maintained that it is unnecessary since there is no arms race in space. Because the CD operates under the rule of consensus, no negotiating body has been established at the CD in Geneva to consider a new space law. Mr. Krepon has been advocating the development of a code of conduct as a more feasible objective in the near term.

At the discussions of the First Committee during the fall of 2007, several countries advocated for such a code of conduct, particularly members of the European Union, as an interim step. Others, including China and the Russian Federation, felt a new treaty was required and offered an outline of such a treaty. The Chinese delegation argued for proceeding on both tracks.

The fourth presentation, on 19 April 2007, was made by Kay Mereish of the biological group of UNMOVIC (the United Nations Monitoring, Verification and Inspection Commission) describing technologies for the verification of declared or undeclared biological activities. Since the time of that presentation, the Security Council has dissolved UNMOVIC. (The annex on page 63 contains a comment on this issue by the NGO Committee on Disarmament, Peace and Security).

The above four presentations can also be found on the web site of the NGO Committee on Disarmament, Peace and Security, at <http://www.igc.org/disarm>, where the slides of three of the presentations appear in color. The web page also contains the edited transcripts of earlier panel presentations organized by the Committee.

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Recommended further reading

The NGO Committee on Disarmament, Peace and Security would like to recommend several articles and publications that have appeared in 2007.

On 4 January 2007, the Wall Street Journal carried an article written by George Shultz, Henry Kissinger, William Perry and Sam Nunn, former US Secretaries of State and Defense, both Republican and Democratic. It was entitled “A World Free of Nuclear Weapons.” An article by Mikhail Gorbachev, entitled “The Nuclear Threat”, appeared in that newspaper, on 31 January 2007, also advocating a world without nuclear weapons.

On 13 January 2008, the Wall Street Journal carried another article written by Shultz, Kissinger, Perry and Nunn entitled “Toward a Nuclear-Free World.” It quoted Margaret Beckett, United Kingdom’s Foreign Secretary, as stating: “What we need is both a vision — a scenario for a world free of nuclear weapons — and action — progressive steps to reduce warhead numbers and to limit the role of nuclear weapons in security policy. These two strands are separate but they are mutually reinforcing. Both are necessary, but at the moment too weak.” It also quoted Mikhail Gorbachev’s January-2007 article in which he said “It is becoming clearer that nuclear weapons are no longer a means of achieving security; in fact, with every passing year they make our security more precarious.”

Richard Rhodes, who has written earlier books about the making of the atomic bomb and the hydrogen bomb, has written in 2007 *Arsenals of Folly: The Making of the Nuclear Arms Race*. It covers the period when Gorbachev was the General Secretary of the Soviet Union and the arms control negotiations of that period, culminating with the meeting of Ronald Reagan and Gorbachev in Reykjavik in 1986 where both agreed on the objective of a world without nuclear weapons. It is published by Alfred A. Knopf.

Jonathan Schell has also written a new book, *The Seventh Decade: The New Shape of Nuclear Danger*. We also recommend it. It is published by Metropolitan Books, Henry Holt and Company.

We also wish to recommend the still highly relevant 2006 publication *Weapons of Terror: Freeing the World of Nuclear, Biological and Chemical Arms*, the report of the Weapons of Mass Destruction Commission headed by Hans Blix. An electronic copy of this report can be found on the internet at www.wmdcommission.org.

The NGO Committee on Disarmament, Peace and Security welcomes your views on these presentations and on other issues of concern to you, as well as it welcomes you to visit the website of the International Panel of Fissile Materials, at www.fissilematerials.org, and of UNMOVIC, at www.unmovic.org, for more information.

We very much hope that these publications and articles will have a large impact on the discussion on the feasibility of disarmament.

A Verifiable Fissile-Material Treaty as a Foundation for Nuclear Disarmament

*Presentation and discussion held on 11 April 2007 at United Nations
Headquarters organized by the NGO Committee for Disarmament, Peace and
Security, in cooperation with the United Nations 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.

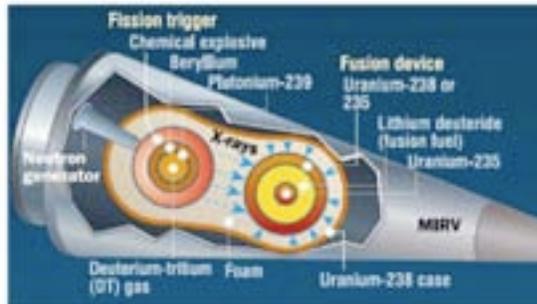
Zia Mian: We will be relatively short in the presentations so that we can take as many questions from you as possible. I am going to talk about the question of a Fissile Material Cut-Off Treaty and what are some of the key questions around it, beginning with a discussion of fissile materials and stockpiles. 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



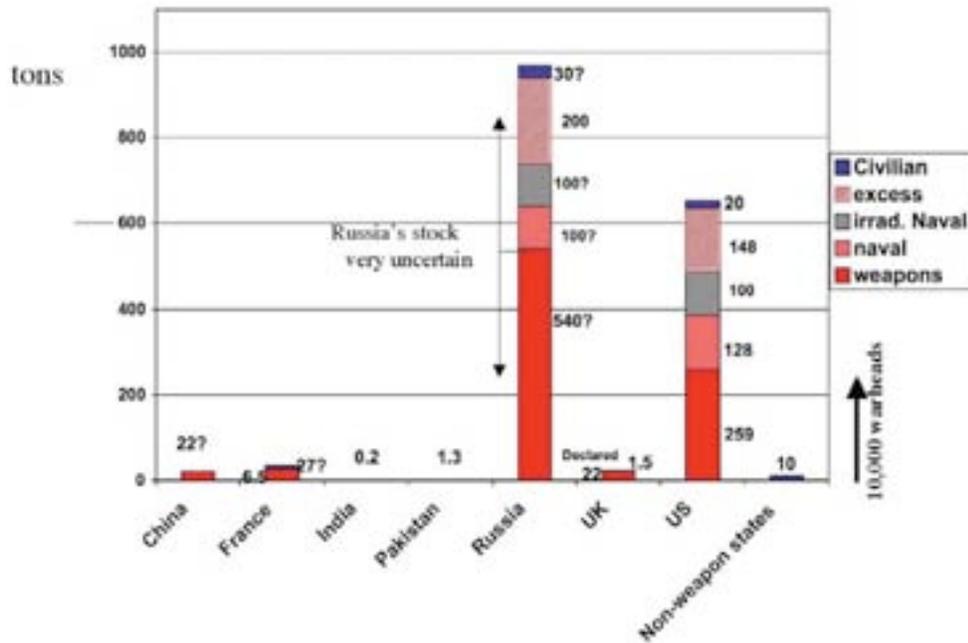
Modern two-stage
thermonuclear weapon
≈ 4 kg plutonium and
25 kg HEU (average)

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.

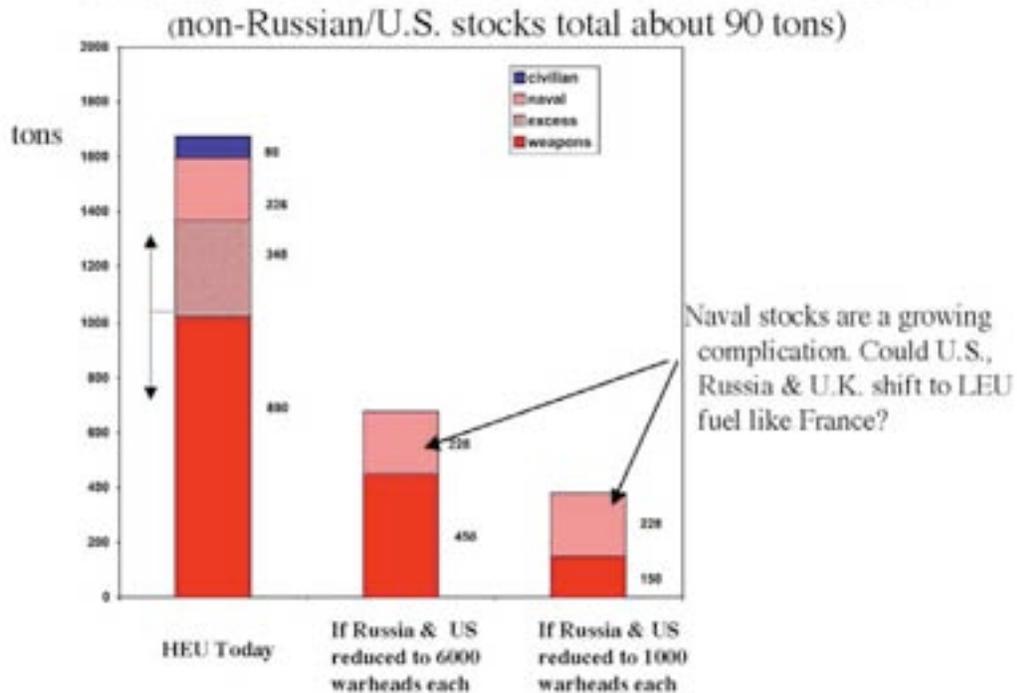
The US and the UK have declared how much Highly Enriched Uranium they have produced for their weapons programs. The others have not. The figure also tries to show the different ways in which this material is being used, so you can see the largest proportion of material is weapons, but there is a substantial 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-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.

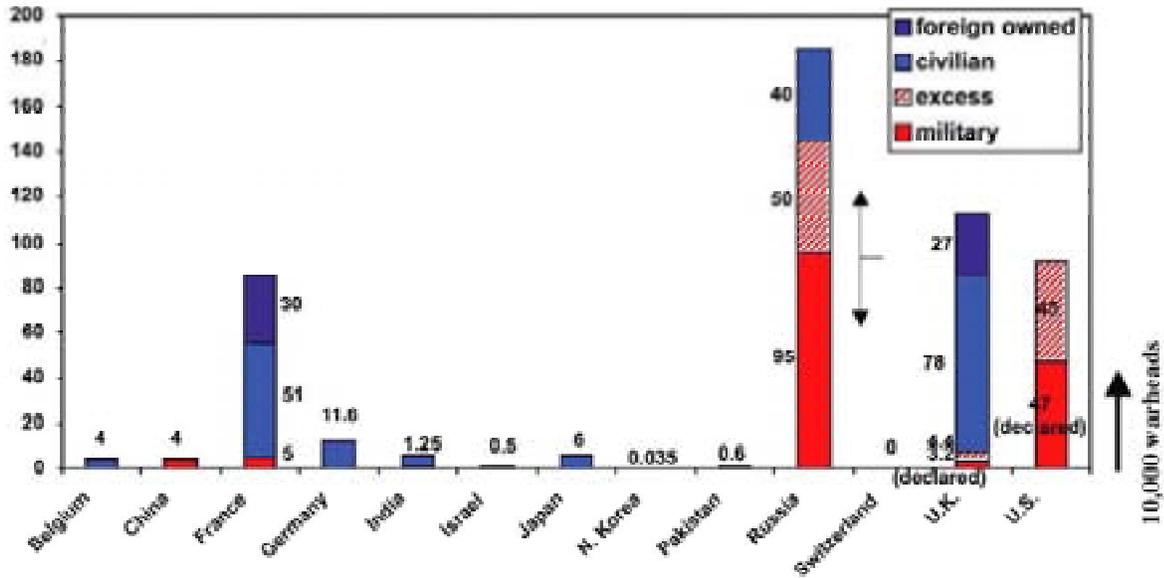
Figure 3. Global HEU stocks: What if Russian/U.S. military stocks reflected warhead reductions?



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.)



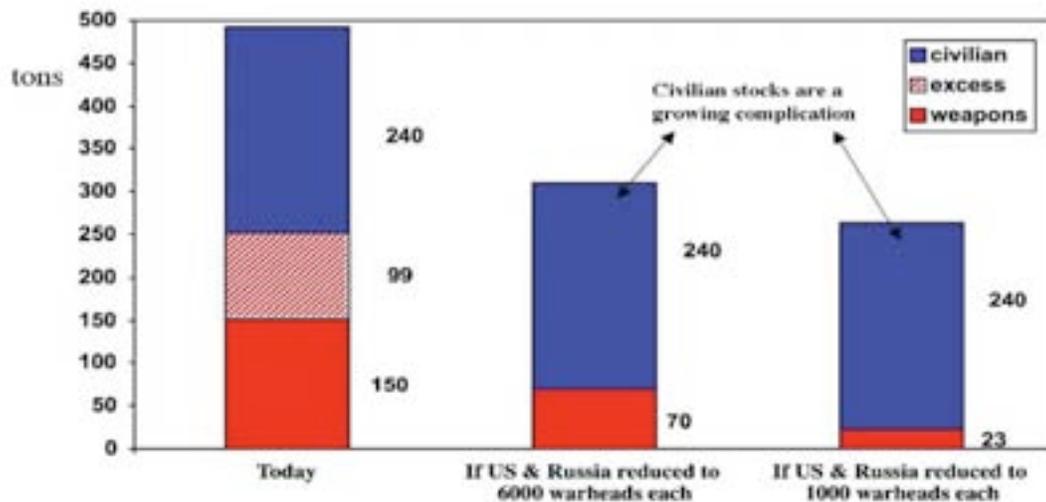
The civil plutonium in non-nuclear weapons states is safeguarded by the IAEA, but there is separated “civil” plutonium in the nuclear weapon states. What happens to these stockpiles? If you add the plutonium in the different categories, you see that there is about 150 tons of plutonium in weapons. The 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 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-nuclear-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-nuclear-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 nuclear-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-nuclear-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-nuclear weapon states. Many enrichment plants in the nuclear-weapon states are already subject to IAEA monitoring. All civilian nuclear activities in France and UK are subject to Euratom monitoring.

Safeguards status of civilian enrichment plants in nuclear-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 nuclear-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-nuclear-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 2112.

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.**

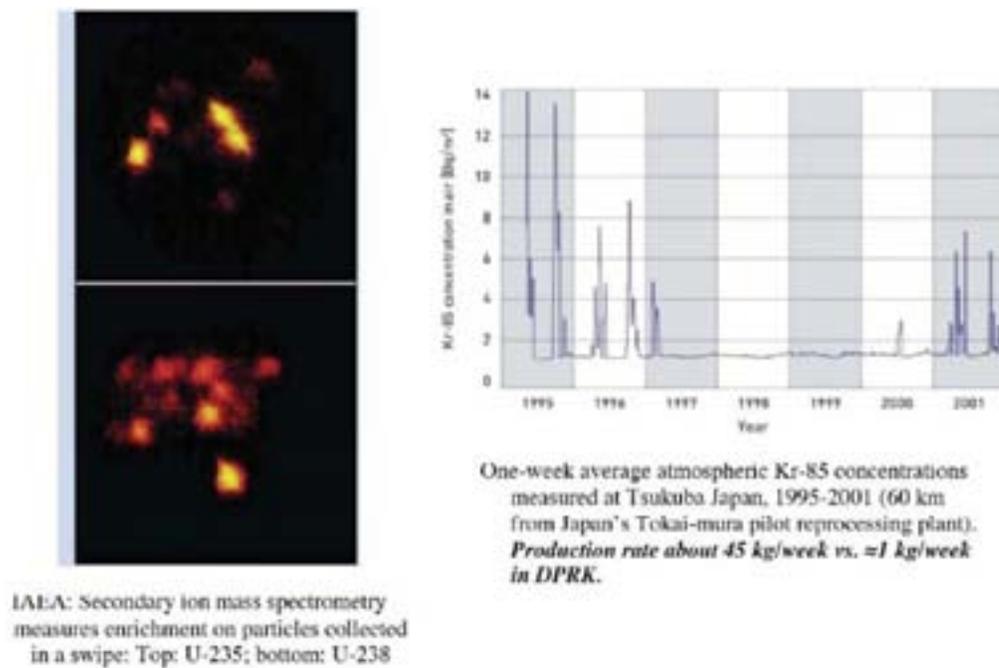
The cost issue has to be revisited in a transparent manner!

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 nuclear-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 moni-

toring 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 unannounced 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 nuclear-weapon and non-nuclear weapon states)



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-nuclear-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.

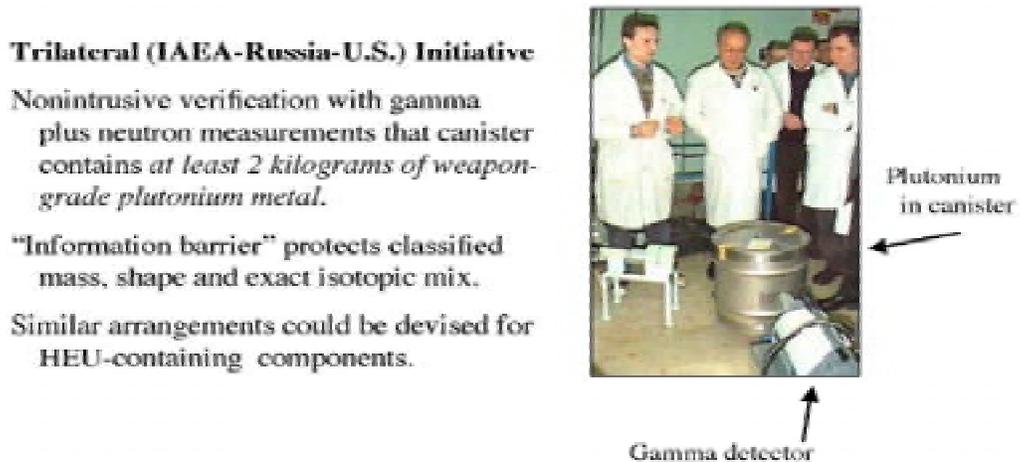
A similar analysis was begun during the Clinton Administration for an FMCT. The IAEA already has the right to request such inspections of military facilities in non-weapon states to determine whether there are any undeclared nuclear activities being carried out there. There is obviously nuclear material 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 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.

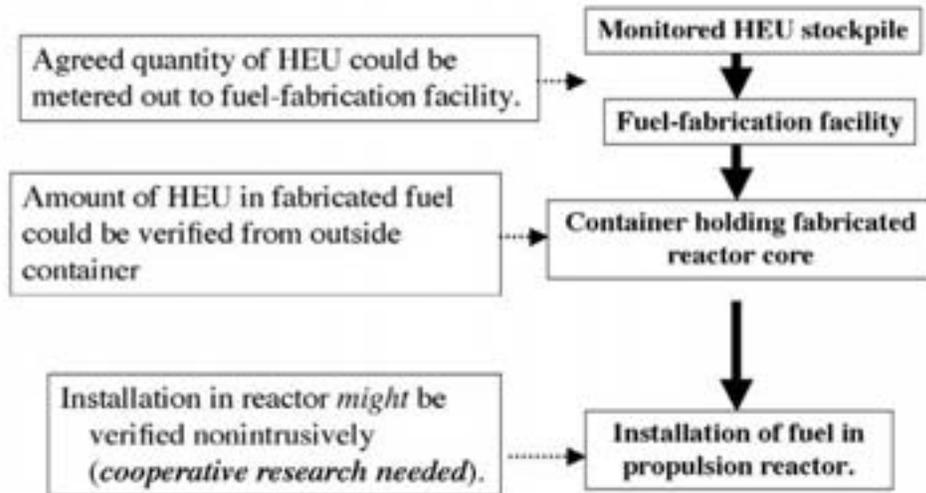
The US provided a plutonium weapons component in a container at a demonstration in Los Alamos, as shown in Figure 10, and showed that by using measurements both the gamma rays and neutrons coming out of the container, one could verify that the container contained at least two kilograms of weapons grade 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



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 nuclear-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-weapon 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-weapon 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.

Panel discussion

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 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 that 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 f. e. 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 state 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 krypton-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-weapon 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.

A Code of Conduct for Outer Space

Presentation made by Michael Krepon on 12 April 2007 at United Nations Headquarters organized by the NGO Committee on Disarmament, Peace and Security, in cooperation with the United Nations Office for Disarmament Affairs

Vernon Nichols (moderator), President, NGO Committee on Disarmament, Peace and Security

Michael Krepon (presenter) Co-founder and Director, Stimson Center

Vernon Nichols: We welcome you all to this discussion. We are pleased to have Michael Krepon talk about a Code of Conduct for Outer Space. Michael Krepon is Co-founder of the Henry L. Stimson Center and the author or editor of twelve books and over 350 articles. Prior to co-founding the Stimson Center, Krepon worked at the Carnegie Endowment for International Peace, the US Arms Control and Disarmament Agency during the Carter administration, and in the US House of Representatives, assisting Congressman Norm Dicks. He received an MA from the School of Advanced International Studies, Johns Hopkins University and a BA from Franklin & Marshall College. He also studied Arabic at the American University in Cairo, Egypt.

Krepon divides his time between Stimson's South Asia and Space Security projects. The South Asia project concentrates on escalation control, nuclear risk reduction, confidence building, and peacemaking between India and Pakistan. This project entails field work, publications, and Washington-based programming, including a visiting fellowship program. The Space Security project seeks to promote a Code of Conduct for responsible space-faring nations and works toward stronger international norms for the peaceful uses of outer space. Krepon also teaches in the Politics Department at the University of Virginia.

Michael Krepon: I want to try and tickle your minds today, to think in creative ways about space, space weapons, and how we can best address this problem of preventing space from becoming a shooting gallery. If that happens, if satellites are targeted — and there are many different ways to mess up satellites, it's not hard — but if satellites are targeted, then everybody loses.

Many of us have become somewhat dependent on cell phones. We have plenty of company. The doctor who needs to make an emergency call or to use his or her pager as well as the patient in dire need of assistance relies on satellites. Ambulances that cannot afford to take a wrong turn when every second counts also rely on satellites, if they use Global Positioning System devices. Tens of thousands of police cars in the United States now have satellites to help them get to where they need to go. We need satellites to warn us of dangerous storms that are approaching landfall. We need satellites to help with disaster relief to know the best place to for helicopters to land amidst the chaos of a disaster scene. We need satellites to help those in harm's way, whether they are wearing a military uniform or not. We need these satellites more than we appreciate — every single day. Satellites are life savers. They are also essential for national security and economic security. The United States is utterly dependant on satellites, and other countries are becoming more dependent on them. Satellites serve global needs.

These indispensable satellites are also quite vulnerable. It is relatively hard to master the art of making good use of satellites, and relatively easy to damage them. Any nation that can place a marble-sized object in the path of a satellite can kill that satellite. In low earth orbit, where many vital satellites are located, any marble, or any marble-sized piece of debris, is a lethal weapon, traveling at roughly ten times the speed of a rifle bullet. It's not simple to put a marble in the path of a satellite; this takes roughly the same skills as putting a satellite into a precise orbit.

Debris is an indiscriminate killer. Any satellite that collides with a piece of debris traveling in low earth orbit with the energy of a one ton safe falling from a five story building will result in catastrophic effects, resulting in far more debris. This helps explain why so many people were so upset with the People's Liberation Army for blowing up an aging satellite in January, 2007. Reputable modeling of the debris field created by this anti-satellite test suggests that it created approximately 40,000 pieces of debris of marble size or larger. Because this test was carried out at a high altitude in low earth orbit, it will probably take a century for this debris field to burn up in the atmosphere. In other words, a country that champions a ban on weapons in space produced — through a single, kinetic energy anti-satellite test — 40,000 weapons in space.

The United States conducted a similar test in 1985, during the Reagan administration. Afterwards, many Americans learned that debris-creating tests against satellites were a bad idea. It took just one test to figure this out, and hopefully it will take only one test for the People's Republic of China to figure this out. The test that the United States conducted was at a lower altitude than the Chinese test, so the debris field took less than a quarter-century to exit low earth orbit. One piece of debris from this anti-satellite test came within one mile of the newly launched International Space Station.

Some pieces of debris are so small that they cannot be tracked — even by the United States, which has the world's best space situational awareness capabilities. Usually, these minute objects cannot be lethal. The U.S. space shuttle's windows have needed to be changed

out fifty-five times because of small debris hits that pockmarked these window panes, but thankfully did not crack them, which could have had catastrophic consequences. China's manned spaceflight is now endangered by debris of its own making — debris that China cannot track. There are approximately 300 satellites in between the debris field created by China's anti-satellite test and the earth's atmosphere. Three hundred life-saving satellites — a huge international investment — have been placed at risk as a result of a single test. Space is endlessly vast, so it is possible that no satellites will be struck by man-made debris (although the United States has already found it necessary to move one of its satellites to avoid a potential debris hit from the Chinese test). But why double the odds of a collision, as the Chinese have done with their January 2007 anti-satellite test?

There are other ways to destroy satellites. One way — also quite indiscriminate — is to use a medium-range missile carrying a nuclear weapon. A nuclear detonation in the atmosphere can do great damage to satellites, irrespective of ownership. The United States learned this in 1962 before the Limited Nuclear Test Ban Treaty, which banned atmospheric tests, was signed. The United States conducted a series of tests in 1962 — the biggest test had a yield in excess of one megaton — and this test series created a radiation belt that destroyed or damaged every satellite in low earth orbit. Not all of them were U.S. satellites.

A number of nations can use nuclear weapons and “hit-to-kill” anti-satellite weapons to create a mess in outer space. These technologies are decades old. There are also more discriminate ways to attack, destroy, or temporarily disable satellites. Lasers and jammers can perform this mission. The Bush administration and the Pentagon would prefer, if push comes to shove and space weapons are used for the first time in the history of warfare, to use weapons that produce temporary and reversible effects. China is working hard on lasers. Russia certainly knows how to use lasers. Many countries can use jammers to try to interfere with satellites. Of course, if one country uses temporary and reversible effects against another country's satellites in a deep crisis or in a war, the country that has been attacked in space may be able to respond in kind. Or the country that has been attacked may decide to fight by different rules in space, or on the ground.

Space-faring nations are therefore faced with a dilemma: Satellites are indispensable, but they are also extremely vulnerable. The satellites of major powers are also intimately connected with nuclear deterrence because nuclear forces depend on satellites for intelligence and targeting information, weather-forecasting data, early warning, and communications. An attack against these satellites in any conflict or deep crisis between major powers could result in unintended escalation across the nuclear threshold. If a shooting war in space is initiated, it could be very difficult to control the shooting and to dictate tactics. It's hard enough for powerful countries to dictate tactics in ground warfare against far weaker opponents. Would it be any easier to dictate tactics in a space war between major powers? The achievement of “space dominance” is very difficult, while asymmetric warfare and counter-punching in space can be relatively simple.

What is the best way to deal with the dilemma that satellites are both indispensable and extremely vulnerable? My analysis suggests that the use of weapons against space objects is not a very satisfactory way to resolve this dilemma. If warfare directed against space objects is the wrong answer, is a treaty banning space weapons the right answer?

Russia, China, and many other countries support a treaty banning space weapons. So, too, do many non-governmental organizations. I have my doubts that such a treaty can be successfully negotiated.

First and foremost, a treaty banning space weapons requires an agreed definition of space weapons. What is it that we seek to ban? Many things can be used as space weapons. As noted above, marbles can be tested, deployed, and used as space weapons. Do we ban marbles? Jamming devices can be used as space weapons. Many countries have jammers. Do we ban jammers? Lasers can be used as space weapons. But lasers can also be used as space tracking, range finding, intelligence collection, and communication devices. Do we ban lasers?

Medium-range ballistic missiles can be used as space weapons. Ocean-spanning missiles, on land or at sea, can be used as space weapons. Certain missile defense interceptors, including those deployed around Moscow and in Alaska and California, can be used as space weapons. Do we ban missile defenses to ban space warfare?

Many different types of weapons and technical capabilities can be used to interfere with or destroy satellites. Because there is so much residual or latent capability to do so, and because these capabilities are essential for other military missions, they can't all be banned. An all-encompassing definition of space weapons is militarily, politically, and diplomatically unfeasible.

An alternative approach would define space weapons far more narrowly — as devices that are specifically designed and tested to interfere with, or to harm in any way, space objects. By focusing only on “dedicated” space weapons, it is possible to avoid the trap of over-reaching. But this narrow approach does nothing to address the wide panoply of capabilities that could still do harm to satellites.

It is, therefore, very hard to define that which a space treaty seeks to ban. One definition of space weapons is far too encompassing, the other is far too narrow. The Carter administration encountered this problem in anti-satellite warfare negotiations with the Soviet Union. Back then, the Soviet Union sought an encompassing definition of space weapons, including the space shuttle, because it had an “arm” made in Canada that could capture a satellite, put it in the cargo bay and take it back to planet earth. Using the space shuttle as an ASAT (Anti-Satellite Attack Technology) weapon would be extremely hazardous and unlikely, but by the definition advanced by the Soviet Union in the 1970s — and by the definition of a space weapon now advanced by Moscow and Beijing — the space shuttle would be an anti-satellite weapon. It will take a very, very long time to negotiate a treaty banning space weapons.

Because a treaty banning space weapons is so hard, does that mean that we are doomed to lose indispensable satellites in warfare? No. We are now in the fifth decade of the space age. In the past half-century, no weapons have been used against space objects in a deep crisis or in warfare. Not one. There have been a modest number of tests of anti-satellite weapons, and in short periods of time, “dedicated” anti-satellite weapons have been deployed by the United States and the Soviet Union. But tests on anti-satellite weapons are a rare occurrence, and major powers have not been eager to deploy or use ASATs.

There were many reasons for this uncommon restraint during the cold war, when the superpowers tested thousands of nuclear weapons, deployed hundreds of new ballistic missiles every year, and maintained their nuclear forces on hair-trigger alert. One reason for restraint was the connection between nuclear forces and the satellites they relied upon. Washington and Moscow knew that to attack satellites would risk unwanted escalation. Indeed, both superpowers negotiated “non-interference” clauses protecting satellites used to monitor each other’s nuclear forces in bilateral nuclear arms control and arms reduction agreements. A second reason for restraint was that the superpowers believed that they would both lose in the event of warfare against space objects. A third reason was that, with so much latent ASAT capability, neither country felt it particularly necessary to repeatedly test or deploy dedicated ASATs.

All of these reasons still apply in crises or limited wars between major powers. Every nation that depends on satellites will lose if those satellites are used for target practice, since vulnerabilities to attack and disruption will continue to override protective measures. If major powers repeatedly test and deploy dedicated ASAT weapons, their security will diminish and the global economy will be placed at risk. A form of deterrence between major powers continues to exist in space, just as during the cold war. Deterrence against space warfare has held for half a century. This form of deterrence has been relatively inexpensive: Unlike nuclear deterrence, it does not require repeated testing, expensive deployments, and hair-trigger alerts. The nation that seeks to upend this deterrence will do lasting damage to itself as well as to others. Because of the enduring indispensability and vulnerability of satellites, the future testing and deployment of dedicated space weapons is not inevitable. If it were inevitable, it would have occurred during the cold war. The reasons why it didn’t occur during the cold war remain valid today. If national leaders are wise, they will not translate military plans into flight tests and deployments of weapons designed to harm space objects.

How, then, do we ensure that life-saving but extremely vulnerable satellites remain available for use when needed? If the use of weapons against space objects and a treaty banning space weapons are not good answers, what is? How can we continue a five-decade long record of uncommon restraint that allows nations to fulfill the vision of the Outer Space Treaty?

The Henry L. Stimson Center has been working with non-governmental partners in Russia, China, Japan, France, and Canada to develop a Code of Conduct for Responsible

Space-Faring Nations. Many codes of conduct already exist. Imagine the chaos that would result if there were different rules for air travel across regions or borders. We rely on codes on conduct for vehicular traffic, ships, and planes. The U.S. and other militaries abide by codes of conduct. Washington and Moscow have signed codes of conduct governing military interactions at sea, on the ground, and in the air. The Incidents at Sea Agreement (1972) and the Dangerous Military Practices Agreement (1989) are model codes of conduct that include provisions that could also be applicable for space.

The outline of a Code of Conduct for Responsible Space-Faring Nations is beginning to come into view. One key element of such a code is debris mitigation similar to the guidelines agreed upon in the Committee on the Peaceful Uses of Outer Space in 2007. There is, however, no holistic approach to a Code of Conduct that is being undertaken by governmental authorities. This is why the Stimson Center and its NGO partners have focused on this initiative.

A Code of Conduct for space is needed because “rules of the road” for space are no less important than rules of the road on the ground, at sea, or in the air. Rules of the road make driving safer; without rules, there would be chaos, and chaos in space is not in the interest of military, business, and scientific establishments. Rules become norms, and norms can become treaties. While rules during peacetime and rules during warfare can be quite different, even warfare has rules. If the analysis presented here is sound, then protections for satellites should also be respected even in the event of warfare. Rule breakers can still be expected, but their presence doesn’t negate the need for rules. Indeed, without rules, there are no rule breakers. Having rules helps to isolate and penalize rule breakers.

A Code of Conduct is needed for space because, while some rules already exist, there are many loopholes. The use of space is expanding, and the potential for friction is growing. The absence of a Code of Conduct and growing concerns over military doctrines for space warfare encourage hedging strategies. These strategies are reflected in the flight testing of multipurpose technologies by the United States and China — technologies that could be used for peaceful as well as offensive purposes in space — as well as by the Chinese “hit-to-kill” anti-satellite test in January, 2007. Hedging strategies are reinforced by the absence of regular discussions or negotiations on space security. This equation means more hedging, less security, and a growing interest in devices that can interfere with or otherwise harm space objects.

A Code of Conduct would serve to increase space security and promote the peaceful uses of outer space — the same general purposes served by a treaty to ban space weapons. A treaty negotiation — especially one carried out in the Conference on Disarmament, which operates by consensus, and which has been tied to a very challenging negotiation for a fissile material “cut-off” treaty — would take a very long time to complete and could result in a lowest common denominator outcome. Even then, the treaty might take many years to enter into force. A Code of Conduct could be produced much sooner, and could be undertaken in many different fora. A small group of stakeholders could work together to produce

a higher common denominator result, which might then be considered by a wider group of countries.

The outlook for a treaty banning space weapons is poor. The outlook for a Code of Conduct is much brighter. The European Union has, in principle, endorsed this idea. The governments of Canada and Switzerland have, as well. The Chief Executive Officer of Intelsat, the largest multinational satellite service provider, has endorsed this idea. Two key publications of the trade press in the United States, *Aviation Week and Space Technology* and *Space News*, have endorsed a Code of Conduct, as well.

What key elements might be included in a Code of Conduct for Responsible Space-Faring Nations? The proposed Code of Conduct devised by the Stimson Center and our NGO partners is built around the key element of no harmful interference with space objects. This formulation, which is borrowed from other agreements, avoids the traps associated with trying to define what constitutes a space weapon. The “no harmful interference” injunction applies to dedicated ASATs, latent or residual ASAT capabilities, and to multipurpose technologies used in a harmful manner. Participating states would still require common understandings of what constitutes “harm,” but this is a far simpler problem than trying to define space weapons. Our proposed Code of Conduct also includes key elements of providing advance notice if there is reason to believe that activities in space may inadvertently cause harmful interference, and consultations when concerned about harmful interference.

What other key elements might be included in a Code of Conduct for Responsible Space-Faring Nations? The proposed Code of Conduct devised by the Stimson Center and our NGO partners also includes provisions to share space surveillance data; to adopt and abide by debris mitigation guidelines for space launches and other activities in space; to refrain from the deliberate creation of persistent space debris; to devise, implement and abide by a traffic management system for space; and to provide accurate and timely launch notification and registration.

This notional Code of Conduct could certainly be improved upon, and the Stimson Center welcomes such efforts. Careful readers will note that which is not included in this short list of proposed key elements: There is no prohibition against space-based missile defenses. This conscious decision reflects several considerations. First, defensive responses to ballistic missile attacks are very different from offensive attacks against satellites. Second, tests of ballistic missile defenses have in the past, and can continue to be carried out, in ways that do not create persistent space debris. Third, attempts to prevent space-based missile defenses by means of a Code of Conduct are likely to prevent its acceptance in the United States. And fourth, the conclusion and proper implementation of a Code of Conduct is likely to reduce the perceived need to test and deploy space-based missile defenses, which have, in any event, encountered sustained political, technical and budgetary roadblocks.

A Code of Conduct for Responsible Space-Faring Nations cannot solve every problem, but it can make many problems less worrisome. A Code of Conduct is no substitute for

national means of defense, but it can make the use of force in space more remote. A Code of Conduct does not take away latent or residual means to carry out attacks against space objects. Instead, these means would backstop proper implementation of the Code. Codes of Conduct to prevent dangerous activities have proven their worth in many domains, including military activities on the ground, at sea, and in the air. A Code of Conduct for Responsible Space-Faring Nations can also make significant contributions to international security.

Comments

Due to an incomplete audio recording of the question and answer session of the meeting, the NGO Committee on Disarmament, Peace and Security asked delegates who spoke to submit their comments. The following are the two comments received after the event by the NGO Committee from delegates:

Comment by Mr. Kuo-Chung Lin

(Kuo-Chung Lin, Ph.D., is the former Secretary of the Disarmament and International Security Committee (First Committee) of the United Nations General Assembly and former Secretary of the United Nations Disarmament Commission.)

“I was very impressed by Mr. Michael Krepon’s comprehensive presentation on the concept of a code of conduct in space made in the discussion held on 12 April 2007 at the United Nations Headquarters by the NGO Committee on Disarmament, Peace and Security, in cooperation with the UN Office for Disarmament Affairs. I wish to maintain the content of my comments made at the discussion on 12 April 2007, which is consistent with my following brief comments.

1. The urgent need of negotiation of a treaty on the prevention of an arms race in outer space

“Since the first Soviet satellite launched into the space the question of peaceful uses of outer space has been systematically discussed in the United Nations Committee on the Peaceful Uses of Outer Space which consists of a Scientific and Technical Subcommittee and Legal Subcommittee as well as in various disarmament forums. All member states of the United Nations expressed their support of the peaceful uses of outer space.

“During the Cold War period, the two superpowers have engaged in an arms race in outer space as reflected in developing anti-satellite system and space weapon system, particularly the SDI program during 1980’s. During the post Cold War period and the beginning of twenty-first century, the issue of prevention of an arms race in outer space continued to be an urgent agenda item in the Conference on Disarmament and in the First Committee of the United Nations General Assembly. There is concern about the so-called absolute security policy pursued by the United States, as reflected in its vigorous devotion to a

missile defense system and space weapon system as well as in its determined withdrawal of the 1972 US-Soviet ABM Treaty. As the record shows, the resolutions adopted by the First Committee on the subject ever since 1982 have been almost an unanimous vote in favor except the against vote or abstention of the United States, which would imply its continued pursuance of a space weapon system.

“The United States has argued that the 1967 Outer Space Treaty already covered the question of an arms race in space. But all other states pointed out that the Outer Space Treaty was mainly dealing with the issue of nuclear weapons and other weapons of mass destruction. It does not cover other weapon systems possibly deployed in space, such as direct energy weapons, kinetic energy weapons, a space-based missile defense weapon system or other new types of weapons system in the future. Therefore, there is a potential danger of a space war which will jeopardize national security and the peaceful uses of outer space, particularly satellite systems. Therefore, there is an urgent need to negotiate a treaty on the prevention of an arms race in outer space as called for in the adopted United Nations resolutions, as preventive disarmament measures, just as the cases of the 1971 Sea-Bed Treaty and 1977 ENMOD Convention.

“Against this backdrop, in 2002, the Russian Federation and China jointly submitted a working paper on the subject to the Conference on Disarmament and the First Committee for consideration (documents CD/1679 and A/57/418), which has a particular connection with the current undergoing US missile defense system, as explicitly pointed out by concerned states in various disarmament forums. The differences of positions on the issue of outer space ended up in the stalemate in work of the Conference on Disarmament for the past nine years since 1997. In this connection, I would suspect that the Chinese ASAT test in January 2007 was merely a message intended to break the US supremacy or monopoly in space weapons systems so as to promote the possibility of commencing negotiation of a treaty on the subject.

“With regard to the difficulty of definition of space weapon, as pointed out by Mr. Krepon, I believe it could be solved in a narrow term for the purpose of the treaty when political will is ripe to negotiate.

2. A code of conduct is rather a civil affairs issue in nature, short of the intended goal on the subject

“In my view, the concept of a code of conduct in space would belong to the area of peaceful uses of outer space, a kind of civil affairs in nature, just like traffic rules or other civil laws, useful measures to promote order and the better utilization of resources in the space community. Therefore, this concept should be considered and negotiated under the Legal Subcommittee of the Committee of Peaceful Uses of Outer Space in Vienna, rather than in the Conference on Disarmament in Geneva, which is dealing with the disarmament aspect of outer space. Indeed, the very nature and scope of the issue of prevention of an arms race in outer space, measures to avoid possible military confrontation among nations,

are much beyond and broader than the civil aspect of a code of conduct in space which is rather a peace-time goodwill cooperation measure. Thus, the concept of a code of conduct in space is much short of the intended international goal and universal commitment to maintain long-term peaceful uses of outer space.

“However, the establishment of a code of conduct in space as suggested by Mr. Krepon will be a useful and good first step, as an interim measure, to promote a peaceful outer space, but it can not be a substitute for the negotiation of a treaty on the prevention of an arms race in outer space. Nevertheless, I would believe that the negotiation on the prohibition of weaponization of outer space and the consideration of establishment of a code of conduct could be pursued in parallel at Geneva and Vienna.”

Comment by Mr. Valery Semin

(Mr. Valery Semin is a delegate from the Mission of the Russian Federation in Geneva, on the Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force Against Outer Space Objects (PPWT).)

“In his speech in Munich on 10 February 2006, President V.V. Putin announced that Russia had prepared a draft treaty on the prevention of the placement of weapons in outer space, threat or use of force against outer space objects. We are now holding consultations on the draft with our partners in a certain sequence. After these consultations, we intend to table the draft PPWT (Prevention of Placement of Weapons Treaty) in the Conference on Disarmament (CD). We hope that we shall be able to do that in not very distant time.

“In the course of the recent CD debates on the issues of outer space we have already reached a common understanding that all States are interested in keeping outer space from turning into an arena for military confrontation, in assuring security in outer space and safe functioning of outer space objects. It is important that we all share this interest. The issue is how to realize this interest in practice.

“Russia is open to all ideas and proposals in this respect. We do not rule out any possibility. But we believe that the best way to meet these goals is to elaborate and adopt a new treaty, i.e. the PPW Treaty.

“First, because new obligations, covering the well-known (and ever-expanding with the development of technology) gaps in international law, must enjoy the same status as the norms and rules currently in force.

“Second, because new obligations will entail inevitable limitations on national military activities and on national business, which should be regulated by domestic legislation, including liability in case of violations.

“Third, because such obligations should be a reliable factor of national security for all states.

“One of the possible options to the new treaty, mentioned sometimes, is working out an additional protocol to the Outer Space Treaty, banning stationing in outer space not only WMDs, but any kind of weapons. We are not against this option in principle. But it is hard to imagine a situation when, at the same time, we would have consensus on such a protocol, on the one hand, and no consensus on PPWT, on the other. If we reach agreement in principle that outer space must not be weaponized, it is better to fix it by an option which is stronger, more focused and detailed, and tailored for realities of today, i.e. by PPWT.

“Transparency and confidence building measures are important for strengthening trust in outer space activities, for enhancing safety in outer space maneuvering, for decreasing motivation for weaponization of outer space, for obtaining the necessary climate for negotiating a new treaty on PPW. Through the relevant UN General Assembly resolution, Russia has initiated a new round of elaborations on updating recommendations on transparency and confidence building measures in outer space activities in the United Nations. CBMs may also become a part of the new treaty. But they can not be a substitution for a legally binding PPWT, they should not deviate our efforts and attention from PPWT in the CD, although reaching a certain agreement on CBMs could be a relatively easy and consolidating step on way to a PPWT.

“Using weapons placed in outer space to assure outer space security, in our view, is not an option, as it will bring less, not more, security.

“First, because it would be difficult to predict the development of the strategic situation in outer space and on Earth due to the *global operating range* of space weapons. It would be impossible to claim that space weapons are “not targeted” at a given nation. Moreover, space weapons will enable to *discreetly tamper with* outer space objects and disable them.

“Second, because the international situation would be seriously destabilized due to a possibility of *unexpected, sudden* use of space weapons. This alone would provoke preemptive acts against space weapons and, consequently, the spiral of an arms race.

“Third, because space weapons, unlike WMD, may be applied selectively and discriminately, they could become *real-use* weapons.

“Fourth, because the placement of weapons in outer space would arouse *suspicious and tensions* in international relations and destroy the current climate of mutual confidence and cooperation in exploration of outer space.

“Fifth, because attaining monopoly of space weapons would be an illusionary goal. All kinds of symmetrical and asymmetrical responses would inevitably follow, which would constitute a new arms race, i.e., exactly what mankind wants to avoid.

“To be sure that no one is preparing to place weapons in outer space — and Russia, United States and Britain have already made specific political statements that they were not doing so — the non-weaponization of outer space should become a universal legally binding norm.

“PPWT is not a new idea. The PPWT will be based on the working document CD/1679 tabled by the delegations of Russia and China together with a group of co-sponsors in June 2002. It will also be based on the abundance of positive results of the subsequent discussions in various forums, reflected in a series of working papers and three versions of Compilations of the views expressed in these discussions. They all are available at the CD web site as official CD documents. So we expect that there will be no surprises in the draft PPWT.

“We are not proposing a PAROS Treaty (Prevention of an Arms Race in Outer Space). But we intend to nip the problem of PAROS in the bud. If we prohibit the placement of weapons in outer space and everyone observes this ban, there will be no arms race in outer space. There can be no room for an arms race there where even placement of weapons as such is forbidden. In other words, by addressing the issue of non-weaponization of outer space we are at the same time averting the danger of a possible arms race in outer space.

“However, this alone is not enough. The normal functioning of outer space objects can be disrupted without space-based weapons, but with weapons based elsewhere or by other actions not related to the use of weapons. In order to protect outer space objects from such a threat and to prevent any other force-related actions in outer space, we propose to supplement the non-weaponization obligation by another one — that of non-use of force or threat of force against outer space objects. Thus, in a certain sense, the PPWT will be a solution of the problem of PAROS.

“We are proposing a treaty which is realistic and practicable. No weapons are placed in outer space now. We want to keep this status quo. We are proposing prevention, which is easier than elimination or limitation or non-proliferation. Nothing of what the states now possess in outer space will be affected in any way. On the contrary, the main purpose of PPWT is to assure that safety and security of outer space assets is guaranteed. This fully applies to the satellites which provide information services in the interests of national defence of the states.

“Compared to CD/1679, the draft PPWT will provide some basic definitions which could be useful for the clarification of the specific scope of the Treaty, but will not make a precedent for the discussions on terms and definitions of international outer space law, which have been going on in COPUOS for decades. These definitions were elaborated in a joint working paper by Russia and China (CD/1779). They are “outer space”, “weapon in outer space”, “outer space object”, “placement” and others. These definitions will answer some important questions. For example, ballistic missiles flying through outer space will not qualify for being “placed” in outer space, and thus will not be limited. On the other hand, these missiles will not qualify as “outer space objects” and will be exempt from the rule of non-use of force against outer space objects. This means that ballistic missile defences will not be limited by the PPWT, except for the prohibition of placement of their “striking” components in outer space, because they would qualify as “weapons”.

“The no-use-of-force obligation is an application of the UN Charter principle to outer space activities. It covers a wide range of possible hostile actions against outer space objects: destruction, damage, injuring normal functioning, disruption of channels of communication with ground command and control centers, deliberate alteration of the parameters of their orbit, etc. In any case, it implies the prohibition of such *actions* against outer space objects, and not the prohibition on the *means* (the hardware) to exercise such actions. It is understood that it would be impractical to create things for the use of force in outer space if the use of force itself is banned. This obligation, inter alia, while not prohibiting directly the development of non-space-based anti-satellite weapons, bans their testing against outer space objects and their use against such objects. This obligation seems to be more verifiable than a ban on the “development” of such systems which may take place in laboratories and within ground testing activities, thus being hard to control.

“Taking into consideration recent developments, we believe that the window of opportunity for negotiating PPWT is not very wide. That is why we can not wait for a long time. To speed up working out PPWT we are not going to provide for a verification mechanism which, for the time being, may be substituted by a set of confidence building measures. A special verification protocol can follow the treaty at a later stage. This does not mean at all that the compliance with the PPWT’s provisions is unverifiable and that verification is not needed. A special study of this issue by our Canadian colleagues (CD/1785) has proved that verification of non-placement of weapons in outer space is possible in principle. We agree with their conclusions. But they have also clearly shown how difficult the practical realization of verification procedures can be. This is also absolutely true.

“No doubt, at this stage it is premature to discuss further details of the PPWT before it is formally tabled. Some details of its contents may be altered in the course of ongoing consultations. Nevertheless, we had two rounds of very useful and productive discussions of the PPWT during the focused thematic debates in the CD in February-March 2007. These discussions have revealed some additional facets of the PPWT scope which may require our further careful consideration.

“Generally speaking, we are driven by the belief that, in the final count, the PPWT will serve the security interests of all states and will contradict the interests of none. We shall hope for your support of it. We expect that after the draft PPWT is formally introduced, the CD will focus its substantive work under the agenda item 3, PAROS, on the issue of the prevention of the placement of weapons in outer space, threat or use of force against outer space objects.”

Technical Advances and Field Experiences for Use in Biological Verification

Presentation by Dr. Kay Mereish, United Nations Monitoring, Verification and Inspection Commission (UNMOVIC), and discussion held on 19 April 2007 at United Nations Headquarters organized by the NGO Committee on Disarmament, Peace and Security, in cooperation with the United Nations Office for Disarmament Affairs

Ann Lakhdir (Vice President for Program, NGO Committee on Disarmament, Peace and Security): We are delighted to have Dr. Kay Mereish make a presentation on the technical advances and field experiences for use in biological verification today. Dr. Kay Mereish has held the position of Chief Biologist of the United Nations Monitoring and Verification Commission-Planning and Operation Section in New York since 2000. She organized and led UNMOVIC biological weapons inspection team in Iraq and she served as chief inspector. She also served periodically as a weapon inspector for several years with the United Nations Special Commission (UNSCOM).

Dr. Mereish served as a research scientist in bio-defense at Fort Detrick for 12 years; served as a senior technical advisor to the US Chief negotiator and as a delegate to the Ad Hoc Group negotiating a protocol to the BWC (Biological Weapons Convention) in Geneva, representing different government agencies, including Defense, State, Commerce, and the National Security Council.

She has published many scientific articles and has presented papers at national and international meetings and symposiums. Dr. Mereish led the development of RNA and DNA-based assay for biological agents; received a patent award in 2001 for inventing an autonomous sampling device designed to investigate the presence of biological threat agents. Dr. Mereish is a pharmacist, holds a masters and doctoral degree from the University of Nebraska Medical Center, College of Pharmacy, in Omaha, Nebraska.

Dr. Kay Mereish: Good afternoon ladies and gentlemen, and thank you, Ann, for the invitation and the introduction, and my thanks to the NGO Committee and ODA for hosting the presentation.

First of all, I would like to acknowledge that the content of this presentation is the result of many years of work by many UN biological inspectors. I am privileged today to present the results of their professional work.

In the next 30 minutes or so, I will attempt to describe some of the impact of advances in life sciences on biological verification and how these advances were applied by UN biological inspectors in the field, noting that this is the only real field biological verification group of inspectors available within the UN system.

Objectives

- To describe the impact of scientific advances on biological verification

- To describe field experience in applying technologies (1991- 2003) by UN inspectors.

2

Similarly, the first chemical weapon inspectors and missile inspectors were also established here at the UN. Each one of these groups also has their own success story of inspection and verification, but this is not the subject of today's presentation.

UN Verification



Missile inspection and destruction



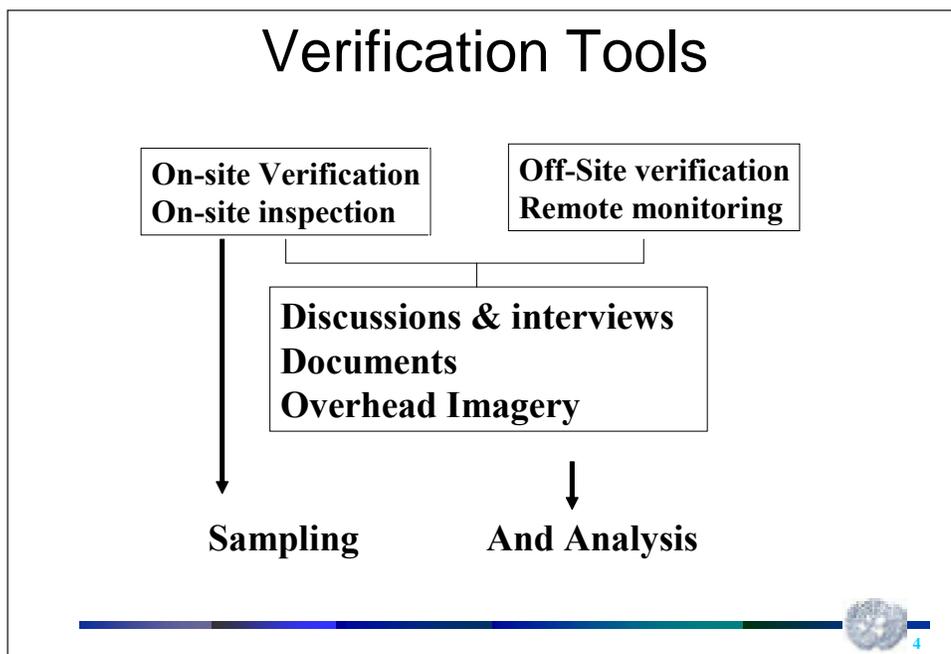
Chemical inspection and destruction of CW agents



Biological Inspection and destruction of BW associated items

 3

However, within the three different disciplines (chemical, biological and missiles), a multidisciplinary approach applied by the commission, the verification tools applied by the inspectors for on-site verification or off-site verification are similar, but the specifics were tailored for each area accordingly.



The value of each tool plays an important role in verification and complements other tools to enhance the confidence level in the verification regime. For each of these tools, the Commission accumulated over a period of 15 years valuable experience and knowledge. For the purpose of today's presentation, one of these tools, "sampling and analysis" within one of the disciplines of "biology" will be described.

From its early establishment, and building upon knowledge and experience gained by its predecessor, UNMOVIC established its sampling and analysis policy in consultations with the College of Commissioners, the advisory board to UNMOVIC, followed by "Standard Operating Procedures" (SOP) for sampling and analysis for all the three disciplines. This document was drafted by the technical staff within the guidance of the sampling policy. The requirement documents for an in-house capability and reference laboratory were established, and upon that an acquisition process was initiated. The equipment and material acquired were used to train the inspectors at UN Headquarters, or for the roster of experts (about 100 biologists and over 380 of all disciplines), as well as they were used during field operations.

UNMOVIC inspectors were equipped with sampling kits and chain-of-custody formats ready for use at any time they were on site, a capability that did not exist before and is the only one in the UN biological inspection. The laboratory capabilities were at two levels: in-house (UNMOVIC) laboratory and a network of international laboratories.

UNMOVIC Sampling & Analysis

- Set up of sampling and analysis policy
- Standard operating procedures
- Requirements
 - Sampling kit, CoC format
 - Laboratory equipment, material
 - Training
 - Reference Laboratories
- Acquisition process
- Field application



UNMOVIC Analysis

- UNMOVIC Laboratory
- Network of International Reference Laboratories



6

UNMOVIC Network of International Laboratories:

ABC Shutz, Germany
Applied Microbiology and Research Centre, UK
Centre de Recherche de Santé des Armées, France
Centre des Etudes du Bouchet (CEB), France
Chemical Defence Lab, China
DST Laboratory, UK
Verification Institute (VERIFIN), Finland
GosNIIOKht, Russia
Laboratorium Spietz, Switzerland
Defence Research Agency (FOI), Sweden
TNO-Prins Maurits Lab, Netherlands



Fee for service arrangements



7

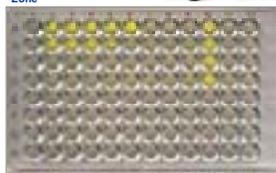
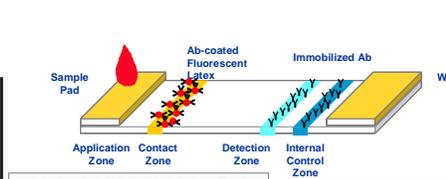
The question is, why such a setup? The reason is, that even though we established a good lab capability, an international network of laboratories certified by local authorities, some international organization and ISO standards can meet the **challenge in case of any possible dispute of results**. The international network of laboratories consisted of highly equipped facilities such as those in: France, Finland, Germany, the Netherlands, Sweden, Switzerland, the United Kingdom, and so forth. Contractual agreements with these laboratories renewed on an annual basis at no cost, using a “Fee-for-service” agreement.

I will go over the in-house capability for biological analysis [and as a reminder, a chemical laboratory was also established]:

First from the basic “Gold Standard” — the classical microscope with reference catalogue, to latest equipment and reagents in detection using “Ab-Ag” reaction platform. The platform of these methods might be universal for use in diagnostics, but the reagents were tailored to UNMOVIC’s need. In simple term, the “Ab-Ag” detection method is based on generating specific antibodies to the toxin or the micro-organism of interest, which is then isolated, and purified.

UNMOVIC Laboratory

- **Microscope**
- **Test Tickets and ELISA**
 - *Bacillus anthracis*
 - *Yersinia pestis*
 - *Francisella tularensis*
 - *Brucella sp.*
 - pox viruses
 - ricin
 - botulinum toxins
 - SEA, SEB, SEC



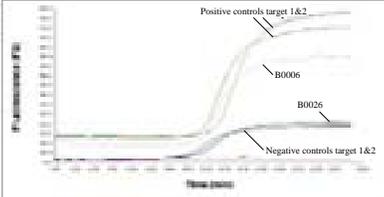
An antigen is a whole bacteria, a specific part of a bacteria, a virus, a toxin from bacteria or plant, which binds to antibodies made in a living organism or microorganism. The antibody recognizes the antigen and interacts with it. Specific markers reveal this interaction in a form of visible color, UV or florescent dyes. Even though this technique has been

around for the last four decades, improvement in the type and quality of reagents continues to enhance the detection limit.

In addition, another technology that was used by the inspectors is called PCR, which stands for “polymerase chain reaction”, a molecular biology technique for exponentially amplifying DNA fragment via enzymatic replication without a living organism.

UNMOVIC Laboratory

- **RAPID PCR**
 - DNA amplification**
 - available targets:
 - *Clostridium botulinum*
 - *Bacillus anthracis*
 - *Yersinia pestis*
 - *Francisella tularensis*
 - *Brucella sp.*
 - *Salmonella sp.*
 - *Escherichia coli* O157:H7

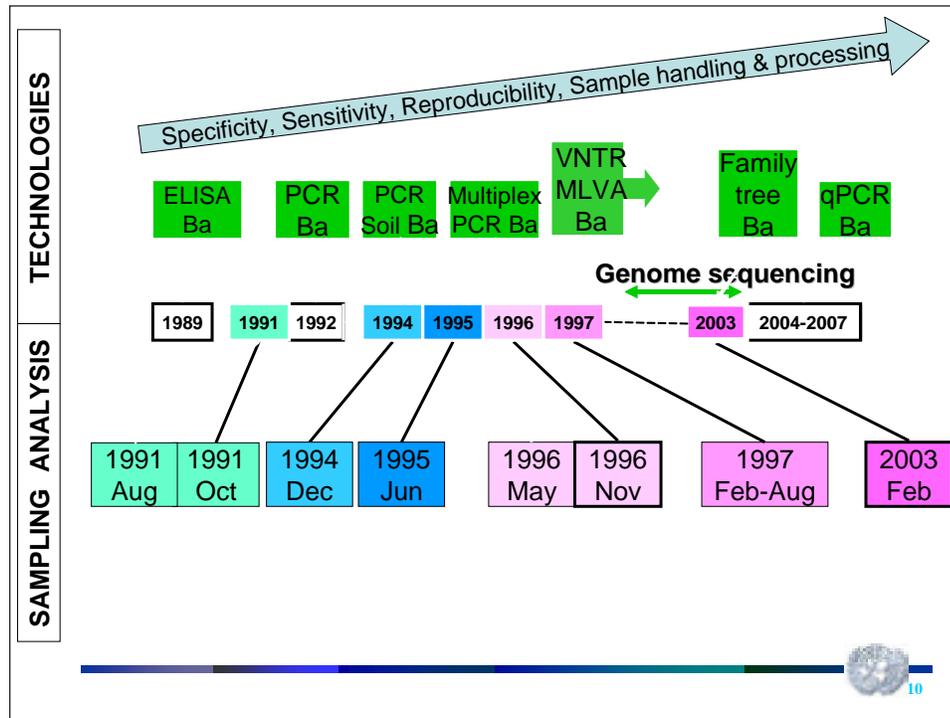


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Reagents for the following microorganism (see slide above) were used, and samples were screened against a battery of these microorganism.

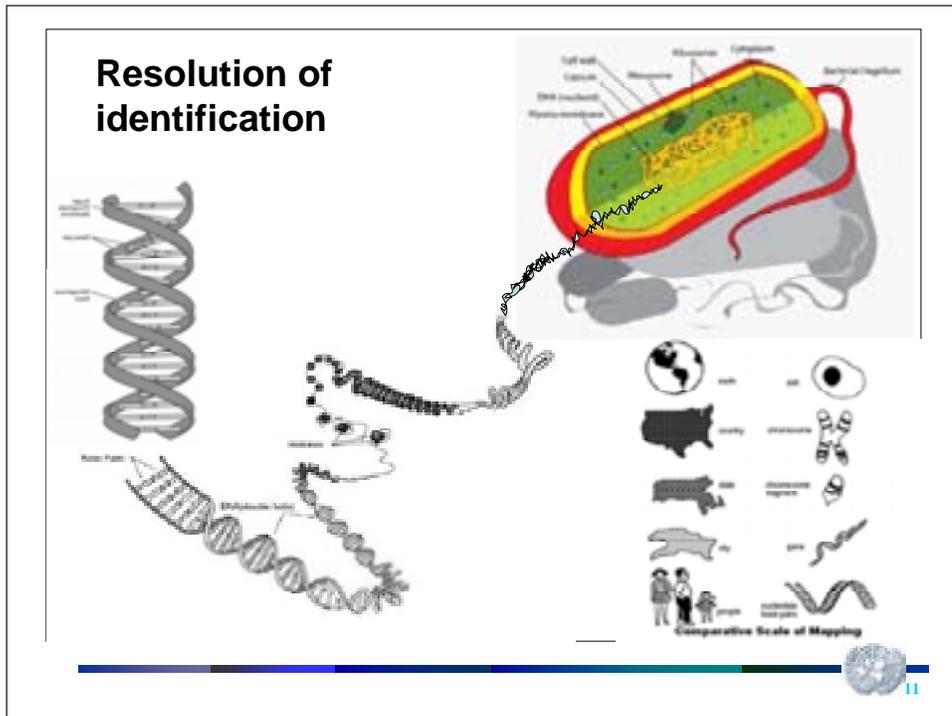
Technical advancement in Bio detection is shown in this slide, which is quite a busy one, but it may demonstrate a point. On the left hand side of the slide, I have sampling and analysis and then the technology. This slide is only made for one biological threat agent “*Bacillus anthracis*.” In the middle of the slide, there is a timeline bar that starts with the year 1989 and ends with 2007, which means that I am covering the period two years before UN biological inspection and up to now. Under this timeline bar, the white lines are connected to dates of major sampling and analysis that took place during the process of inspection and verification. On top of the time line the green boxes are a summary of major technological events applied for the detection and analysis of *Bacillus anthracis*. Some of these advancements are also applied to other biological threat agents. In brief, early on diagnosis and detection of the disease of *B. anthracis* and up to 2002, FDA (Federal Drug Administration), WHO (World Health Organization) and many other health organizations relied on what is called the “Gold Standard” for detection, which is culture and microscope

methodology. That works well for a clinical setting, and in some aspects in verification if you have a sample that contains a micro-organism; it is the method to use.



But in cases of investigative verification, in which you do not have a micro-organism to see under the microscope or to grow in a culture plate, but you may have an antigen, a protein fragment that might be an antigen, in such case you use the Ag-Ab platform, and that might work. But what if you do not? You may find a small piece of DNA. And the way to find that piece is through “ PCR technology”.

When the Commission started its work in early 1991, PCR for BW threat agents was not widely available except in a few laboratories. After all, PCR was only discovered in the late 1980’s, and Dr. Kary Mullins received his Nobel Prize for this technique in 1993. The technology that started by heating and cooling a tube manually containing enzymes and reagent to multiply a fragment of DNA continued to advance in equipment automation, better reagents, enhanced reaction conditions, enhanced markers, and new ways to identify the DNA fragment. PCR technology was first used in medicine rather than in “bio-defense,” since BW threat agents are not day-to-day diagnostics at clinical laboratories. In addition, the specificity of the test continues to be enhanced. One major application of advancement started in 1997, and continues to have an effect on the identification of the family tree of bacilli in nature. This is called VNTR, SNP in conjunction to genomic sequences of this bacteria. Our understanding and classification continue to be refined.



In my cartoon demonstration above, the resolution of PCR technology is, if you look at this bacterium, the yellow entangled thread inside represents its genomic DNA. If you tried to untangle this DNA, by pulling it (gently) out, you can see how it looks. With further magnification and de-entanglement, you can see something that you are familiar with, the double helix shape of a DNA, and these lines inside are called base pair. Now if you can imagine this small piece, it represents a child on earth, while one human chromosome is like the size of the United States (see insert in slide). Reading these base pairs of the whole thread is what is called the full genomic sequence of this bacterium. It is interesting that there are only certain pieces of importance. They are in certain bacteria, or a specific isolate, and not in another. These differences are the ones that we magnify by multiplication and use for identification.

Using this technology, I would like to go over two examples from the field experience. The first one is in the identification of Brucella in an infant formula company.

Example 1: Verification of Brucella



PCR machine + DNA
+ Reagents

Spray dryer from the infant formula plant where UNMOVIC took samples in 2003. Two samples within this spray dryer were positive for *Brucella* DNA; 10 samples from other locations were negative.



This company was bombed in the first Gulf War in 1991, and all its equipment were damaged. The UN Commission inspected and monitored the site through 1998. This spray dryer has been lying in the open. In 2003, an UNMOVIC biology team visited the site and took samples. What are the possible micro-organisms, DNA fragments or antigen present in a piece of equipment? The samples were analyzed by the in-house methods that I described earlier. We were looking for Ab-Ag immunoassay, ELISA, and PCR assay, and any residual DNA. All performed analysis gave negative results for the tested agent except one, the agent that causes the disease “Brucellosis.” There are many types of Brucella. The one that causes disease in cows is different than the one that causes diseases in pigs and so forth.

The melting point of the DNA from the spray dryer was compared to DNA isolated from milk sold at the cafeteria in Baghdad and to DNA samples from a canned milk produced in the United States of America. Using UNMOVIC Laboratory capabilities, it was concluded that:

No presence of *Cl. Botulinum*, *Y. pestis*, *B. anthracis*, *F. tularensis* using the PCR technique. No presence of SEB, BotTox or Ricin, using the immunological Ab-Ag assay methods.

Significant presence of Brucella DNA consistent with natural contamination of dairy products was found in the milk from the cafeteria in Iraq (compared melting point of DNA *Brucella abortus*, *miletensis*, *ovis*, *canis*, and *suis*).

RESULTS

- No presence of *Cl.botulinum* *Y.pestis*, *B. anthracis*, *F.tularensis* (PCR). No presence of SEB, BotTox or Ricin (immunological).
- Significant presence of Brucella DNA consistent with natural contamination of dairy products in Iraq (compared melting point of DNA *Brucella abortus*, *miletensis*, *ovis*, *canis*, *suis*).



The second example from field verification is the verification of *B. anthracis* weaponized in aerial bombs, the identification of the weaponized isolate and verification of the type of isolate destroyed in 1991 and found in samples taken in 1996 from the dump site outside the production facility. Samples were analyzed in-house as well as at two laboratories from the international network established by UNMOVIC, and for the presentation today, they are Lab A and B.

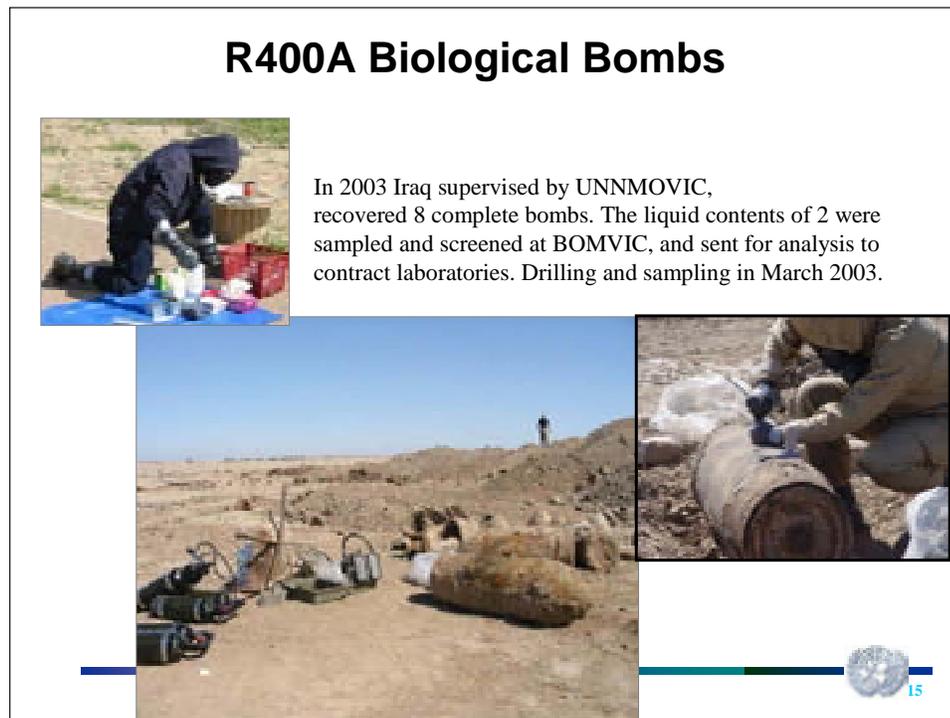
Example 2: Verification of *B. anthracis* in bombs & at dump site

R400A Biological Bombs



Dump Site





Samples were analyzed in-house as well as at two different network reference laboratories, laboratory A and B.

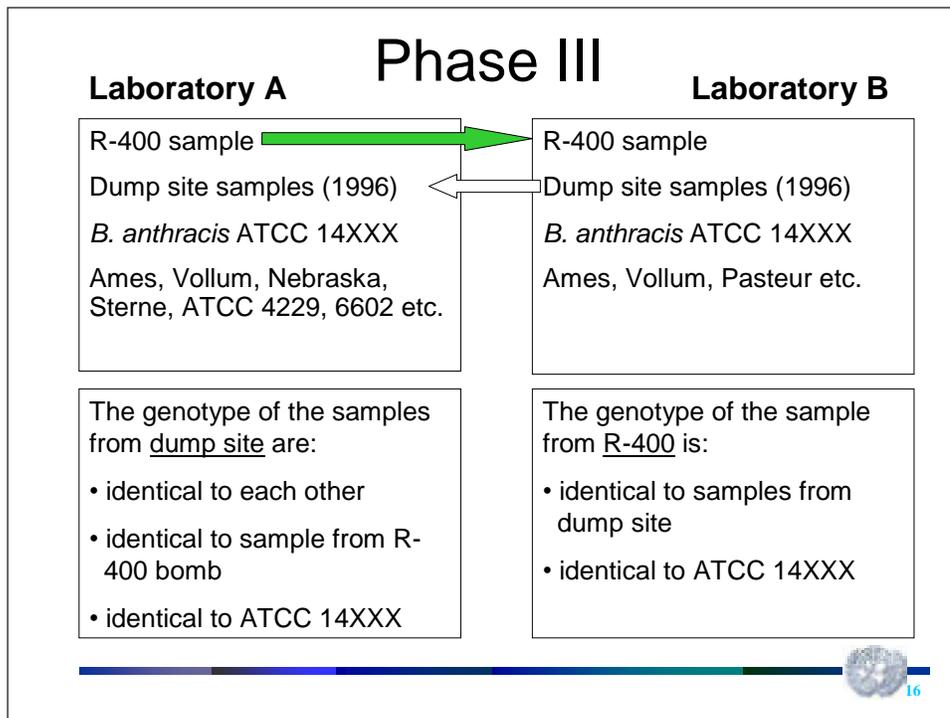
Three stages of analysis were performed:

First, for the detection of CW agent, degradation products, precursors and/or their degradation products. The first round of testing revealed that all were negative.

The second level was to examine for the presence of: chemical decontaminating agents used to deactivate biological agents; any antigen; any proteins or DNA fragments. The results revealed the presence of two decontaminating agents as declared by Iraq, few protein fragments, no bacterial growth and DNA of *B. anthracis*.

The third stage was identification of the type of *B. anthracis*. PCR, VNTR, and SNP techniques were used and results compared to several isolates such as volume, ATCC strains, Ames, Nebarsaka, etc.

It was very clear and both laboratories confirmed that the type of isolate is the same as declared by Iraq and not an Ames isolate. (Note: Ames isolate was identified to be the type of *B. anthracis* in the anthrax letter attack in USA of 2001). The technologies applied in 2003 for the identification of the isolate was not available in 1996 to fully identify the isolate at the dump site.



RESULTS

- Bacterial DNA in exposed equipment for 12 years or in munitions were still detectable by techniques used by UNMOVIC biological analysis laboratory.

- Demonstrated the capability to detect trace evidence of biological warfare agents in equipment even if production is no longer ongoing or if there were significant efforts to decontaminate the equipment .



RESULTS

- Using genotyping analysis the Commission verified that Iraq produced and weaponized *B. anthracis* of ATCC strain as declared, and not the Ames strain.
- Advancement in technologies allowed UNMOVIC in 2003 to verify **qualitatively** Iraq's declaration on *B. anthracis*
- Advanced application of qPCR may allow a closer **quantitative** verification in the future.



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In conclusion:

Conclusions

- Genotyping analysis is a powerful verification technique.
- Advancement in technologies when applied makes biological verification a reality.



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References: See Security Council documents, UMOVIC quarterly report.

S/2003/580; S/2003/844; S/2003/1135
S/2004/160; S/2004/435; S/2004/693; S/2004/924
S/2005/129; S/2005/351; S/2005/545; S/2005/742;
S/2006/133; S/2006/ 342/ ; S/2006/701; S/2006/ 912

Panel discussion

Bhaskar Menon (former editor of *Disarmament Times*): Can you date the fragment? Can you say how old it is?

Dr. Kay Mereish: We can date, not the fragment, but maybe associated things. DNA itself, I don't think you can date it, as far as I know. In the process of dating either carbon or the oxygen ratios are used. We have not seen dating with DNA fragments. It could be possible, but I have not seen it.

Bhaskar Menon: You mean carbon dating?

Dr. Kay Mereish: Yes, the basic elements of the four bases making the DNA are, carbon, hydrogen, oxygen and nitrogen, so if you have a technique to date carbon with some precision, then it could be done. There is natural deterioration of the DNA. This DNA is leftover after not just natural deterioration, but they added chemicals to it; they cooked it in the vessel which is like a pressure cooker at 120 degrees under pressure, and they also added formaldehyde. So it was in pretty bad shape. But still we were able to find sufficient fragments to identify. This shows you the power of the forensics.

Shirley Chesney (Peace Action): Is there a basic worldwide registry of biological weapons? People say that the United States and the former Soviet Union had large numbers of biological weapons. What is that based on?

Dr. Kay Mereish: The current Biological and Toxin Weapon Convention has no verification protocol. There is something called Confidence Building Measures. The CBMs have different formats, from A to B, C, E, F. This is not obligatory; it is optional for the States Parties to file them once a year. Format F only relates to past biological weapons programs with information on which agent and what quantity. The United States and the former Soviet Union filed their format Fs many years ago. If you are a signatory to the BTWC (Biological and Toxin Weapons Convention) you should have no biological weapons at all.

Is there inspection? No, there is no inspection. After the Third Review Conference and the special conference in 1994 an Ad Hoc Group was set up to negotiate a text, a verification protocol, that could be adopted. That effort basically ended in 2001. The Ad Hoc Group no longer meets anymore to negotiate a protocol which was to have included an inspection regime.

Paolo Cuculi (Mission of Italy): I have had the privilege of participating in the work of the Ad Hoc Group during its last year in Geneva. I have one general and one specific

question. The general question: Without entering into the big debate that used to take place about whether biological weapons are verifiable or not, one of the main arguments which was given at a certain point, reversing a previous position, was that you cannot really tell whether a program, especially in specific facilities, is defensive, which is allowed by the BTWC, the Biological and Toxin Weapons Convention, or is offensive, which is forbidden. So if my good friend from Pakistan comes to Italy and wants to make an inspection of one of my facilities which is producing vaccines, or even more sensitive, to a military facility, and let's assume that my government allows an expert from Pakistan to come to my facilities. And he finds something, and I say look, this is not for a bio-offense programs. It is only for prophylactic defensive allowed purposes. Is it a silver bullet to say, I am sorry, this is indeed an offensive program, forbidden? Bio-defense facilities, vaccine facilities, the dual-use aspect of BTWC are most evident.

Second question: When we were negotiating the BTWC verification protocol, one of the big issues was the one about the timing for allowing inspections. I am not talking now about the routine visits that every State gets, but the most serious case. There is an alleged suspicion, whatever body allows for an inspection, the inspection team has six hours to access the facilities. In terms of the possibility to conceal the contaminants, in view of your last presentation and PCR, how relevant would be the time factor in that respect?

Dr. Kay Mereish: Excellent questions; and they are right at the heart of the discussion of the last several years. To take the first question, can you tell an offensive from a defensive program? It is not a yes-or-no answer. If you have a bio-defense program, you are supposed to declare your activity under a specific formula within the CBMs. If you declare a certain type of vaccines of specific agents, many times the vaccine strain is a different strain from an offensive one. That is one aspect. Secondly, some strains of vaccines against bacteria or viruses are the same bug that causes the disease. So how do you tell the difference? At the end, the bug must be de-activated by a specific chemical. You don't need to see the detailed processes from A to Z as long as they are willing to reveal the last stage of de-activation. Then you are in a good position to say this is a vaccine.

For example, with regard to the botulinum toxin for vaccination purposes — we don't administer the toxin as is. It is a de-activated toxin, and it is produced in bulk. So you could differentiate by the end product. Sometimes you could differentiate in specific organisms by the genotyping of that organism.

You may say this is very intrusive, to take a sample. This was part of the whole negotiation in Geneva over the Protocol. At the end, what did they agree upon? They don't want sampling, they don't want analysis or photography. Basically you go and use your nose will smell the bacteria and decide whether it is offensive or defensive? This is not science and it cannot be done. If you are honest, and you have a bio-defensive program producing a vaccine, submit your sample, let it be tested. The science technology is available to really show that. I am talking about a small sample.

What is the difference between offensive and defensive? It is the quantity which is addressed in Article 1 of the BTWC. You should have only quantities meant for prophylactic purposes. If you have a quantity above and beyond the need, then you have a question mark and you need to go through a clarification and consultation activity, not different from what you have in Article 9 or in the Chemical Weapons Convention (CWC). There are answers to these kinds of things.

Your second question; to me timing is not an issue. I know they were talking about 24 hours, 48 hours and so forth because of decontamination. If you give me access to the equipment, I could be delayed. I showed you that after 15 years a sample picked up the DNA in a very specific location from a spray dryer sitting in the sun for all those years since 1991. I know that the technology right now is getting better and better to meet the FDA requirement and that of many other agencies. It is difficult to wipe off completely the DNA of microorganism. You will be able to pick it up if you have access and you know where. So the question is access. The question is the ability to accept that the team is able to sample. If you don't want your sample to leave, the equipment is small. You could take an equipment like the one I showed earlier for the PCR with you, as they do in the CWC. You could run the analysis on site, destroy everything on site. The State Party says this is confidential information. The inspectors could say, you keep it to yourself, we are not taking it away with us. This concern could be answered.

Lots of the positions taken then in Geneva were not based on scientific, technical values. It was based on other motives. It is easy to say you can't verify biological weapons. It is much harder to say, yes I could verify it. And ladies and gentlemen, we have proven this over the period from 1991 to 2003. We have proven biological verification is a reality. It is not a dream and it is not a political issue. I am talking purely technicality.

Dorothy Prunhuber (Ribbon International): Have biological weapons been used by the United States and its Allies in Iraq to our embarrassment?

Dr. Kay Mereish: I don't think it is an embarrassment because I don't think there is any allegation of use. It would be easy to determine if there were any use, but UN teams were in Iraq up to the 17th of March 2003, and they have not been back to any further investigation.

Ewen Buchanan (UNMOVIC): Is it not true to some extent that UNMOVIC and UNSCOM were lucky because of the passage of time? When the Iraqis did their destruction they had no idea that this technology was coming down the road. The measures they took in those days they thought were sufficient to fool us. You have to some extent just told me what I need to do to counter the new techniques.

Dr. Kay Mereish: You are right. In 1991 no one knew that the technology will be so good. Even in 1996 samples taken were not fully analyzed because not all the capabilities were there. Did I tell you what you would have to do to decontaminate? Not really. The

technology is moving at a much faster pace to beat those proliferators, if they want to cover up their tracks.

But the issue is, the UN must stay on top of this technology, to acquire it, to have laboratories, maintaining these laboratories, to stay on it, in case it is needed. That capability exists now. Otherwise it will be very difficult to acquire it and to do an investigation. This is really the issue. Right now as long as our laboratories and our inspectors are ready and qualified, we have the capability to do it. To maintain such capability is a question the UN needs to face in the future.

John Kim (Fellowship of Reconciliation): I want to thank you for the excellent presentation. UNMOVIC was originally created by a Security Council resolution. Does UNMOVIC still report to the Security Council? UNMOVIC's operation in Iraq was suspended because of the US invasion. Why isn't UNMOVIC allowed to go back to Iraq to finish the job?

Dr. Kay Mereish: UNMOVIC and the inspectors I was talking about were established by UN Security Council resolution 1284 of 1999. UNMOVIC followed the previous commission that was established by UN Security Council resolution 687 of 1991 that was called UNSCOM. Our reporting is required by both Security Council resolutions. There is a quarterly report to the Security Council and a briefing. The Commission continues to report to the Security Council and our reports are available as S documents. We continue to be an organ attached to the Security Council.

Why have we not gone back since 2003? The security issue is a big issue. Secondly, there was a letter from the United States and the United Kingdom to the President of the Security Council saying that they are the occupying power and they are taking over the issue of disarmament and they will inform the Council with the results of their disarmament activities. That basically put UNMOVIC out of the issue of disarmament. At the same time, in their resolution of May 2003, it was said that the mandate of UNMOVIC will be revisited in the future. So far that has not been done. So UNMOVIC continues to exist as long as the Council wishes it to exist, and we continue to update our skills and our inspectors and our technology, even though the conditions have changed. But I think the UN is definitely in need of some kind of expertise in the future for whatever purpose the Council decides.

Barbara Rosenberg (Scientists Working Group on Chemical and Biological Weapons of the Center for Arms Control and Non-Proliferation): I would like to say two things. First, on the question of decontaminating a facility before inspection. Any attempt to totally decontaminate a facility would require dismantlement of the equipment because it is in the screw threads. There is always some residue. So that kind of dismantlement would itself be a give-away.

Second, I want to bring your attention to a paper entitled *A Counter-Bioterrorism Strategy for the New UN Secretary-General*. It has just appeared in the spring issue of *Disarmament Diplomacy*. It discusses various ways in which technical expertise, including the kind we have just been hearing about, could be made available on a permanent basis

to the Secretary-General and the Security Council. The paper shows that costs don't have to be prohibitive. There are potential cost-saving arrangements that could be made and the paper has an appendix with detailed cost estimates. In addition, the paper takes up the Biological Weapons Convention and proposes an alternate route for strengthening it in the future. Anyone who is worried about the threat of biological weapons has got to recognize that present arrangements are not adequate. Let us hope the new Secretary-General is ready to take new steps to fill the gap.

Sohrab Kheradi (NGO Committee on Disarmament, Peace and Security, and former staff of the UN Department for Disarmament Affairs): The issue goes back to 1978 with the resolution that was adopted concerning the alleged use of chemical weapons and biological weapons by the Soviet Union and its proxies. A number of investigations were carried out on the borders of Afghanistan, Cambodia, Laos and so forth. Pursuant to that a report was submitted and certain parameters were set out concerning procedures, laboratories, sampling techniques and analysis. Later on, perhaps in 1984 or 1985, the General Assembly asked a Group of Experts to devise a set of procedures to carry out investigations of chemical or biological weapons allegations. And this goes back to the Geneva Convention of 1925. In that set of procedures very elaborate detailed mechanisms were provided. I am curious, how much did you draw on all of this in setting up UNMOVIC?

Dr. Kay Mereish: Definitely. It is in the heart of what we have gained of knowledge and experience. I remember all these procedures, the laboratories, the inspectorate. At the time we set up our operation in 1991 they were not really updated. Technology continued to move, and we had to continue to move. A lot of the laboratories that were listed do not exist anymore. Some of the experts on the list have deceased. So what we did, we built it up — the reports, about 12 of them on investigations under the Secretary-General's mandate. A lot of them tend to cover chemical use and the yellow rain, the tricothecene and so forth. We did the best we could by looking at all these procedures and documents. But we have greatly updated them to meet the standards and requirements of today. So we looked into them.

To my understanding, there is an on-going process within ODA, the Office of Disarmament Affairs, that ODA is also in process of updating the Secretary-General's mandate with regard to procedures and the list of experts. We [UNMOVIC] built on a lot of that experience, as well as the experience from 1991 to 1998, the UNSCOM experience. We did not leave anything out that we could utilize and benefit from. In addition, a lot of our experts — they are either experts in bio-defense or chemical-defense — and we have learned from those experts.

Khalil Hashmi (Mission of Pakistan): I have several questions and comments. First of all, as my friend Paolo said, during the negotiations of the Ad Hoc Group which I was not so fortunate to participate in, there was also a broad concern expressed in terms of the possibility of commercial concerns regarding privacy and patents. You have rightly concluded that technically speaking, verification is possible and doable. How far, in your

view, if there were to be an organization set up, would there still be a concern that some commercial secrets, some bio-technology, patents or other thing would be violated?

You mentioned that UNMOVIC has about a hundred bio-experts and 300 inspectors that are still on the roster. Do you have accreditation with specific labs that you have at your disposal? All of these are being paid out of the UNMOVIC budget, which is paid for by Iraq's oil revenues.

We hear a lot these days about proliferation concerns. That brings into focus the issue that a few are more holier than others. A few get more credit than others. When Iraq declared in 2002 and filed a very comprehensive declaration on its nuclear, biological and chemical weapons, I think that most of us know that at least the names of 82 companies were eliminated from that declaration. Many in the international community do not know the names of those companies or what they supplied Iraq with. Later on UNSCOM and UNMOVIC were sent to verify the materials and equipment which in the first instance were sent by those 82 companies.

Probably last year, when UNMOVIC published a report giving the latest state of their work, I think the College of Commissioners was given a report but a major part of that report was also eliminated and it was not published. The report that was sent to member states indicated that it was too sensitive to include. We don't know the reasons why this part was eliminated, but I am sure there must be some material in it that was considered of proliferation concern. If you could shed some light on that.

Dr. Kay Mereish: On confidential business information, if the site is a government site or a private site: As I mentioned, this was a concern when we were negotiating the Protocol. The answer, if I go on site; you are allowed to shroud certain sections of your production line that might reveal a process, a patented process and an important sequence in your production line. If you also have concerns with your CBIs, you don't need to sample the tank where you are cooking your biotechnology material as long as you allow the sample downstream from that line, and I could verify the final product that you are going to put into the market. You cannot deny it and say that this is CBI.

I do not need to analyze the sample of the host agent from the fermentation vessel which may reveal how you modified it. That is the issue. There is patent that industry likes to protect and there are processes. If you look at the Chemical Weapons Convention (CWC), businesses are protected. Biology is no different. It is possible to protect the company's assets and still verify their activity. So that is my answer to the CBI issue.

Second, accreditation of our laboratories: As you know, in the bio arena, accreditation is offered through a public health ministry within the nation. The other is WHO (World Health Organization) laboratories. ISO Laboratory standards are generic. You could say it is an Administrative ISO, as well as there are standards for laboratories. The laboratories that we dealt with, all of them, meet all these types of accreditation.

We, as a bio community, do not have accreditation as established under the CWC or the OPCW in which the laboratory used had to pass a specific type of testing, round robin testing. The BTWC has no verification protocol, and so there is no body to do the accreditation. You might recognize that the accreditation requirement of public health agencies and of WHO is not the same requirement for weapons testing. It is different. Our forensic testing is looking for a bio-defense or an offensive material. We are looking for these DNA fragments. Public health does not do this on a routine basis because they are looking for disease-causing material, not for forensic analysis.

In the future, when there is a verification protocol for the BTWC, there will be a need to set up these laboratories in the same fashion as the CWC set up their laboratories and required special testing. The requirements are different. You had to set up exactly what agent you wanted the laboratory to test. There is no one laboratory that I could be certified to test all the viruses and all bacteria's and all antigens. It is a tremendous effort. So you will have only certain categories of these agents that could be certified in certain laboratories. This is something to be pursued by the United Nations when they are ready to establish a verification protocol or even under the Secretary-General's mandate, if he wishes to establish it under his investigatory power. Because submitting the name of a laboratory that is willing to help the Secretary-General is insufficient. You must establish requirements and you must have those requirements met for your future possible investigations. The Secretary-General's mandate that was set up in 1982 and 1983 has nothing to do with the requirements. It was too early then. It is insufficient by today's standards.

Third, concerning the 2002 declaration and sanitization: The 2002 declaration submitted by Iraq was sanitized by the Commission to eliminate proliferation concern. I am not going to answer the question because I was in Iraq and our Public Affairs Officer was here and in charge. He could answer that question.

Ewen Buchanan: I should point out that the decision to "sanitize" the Iraqi declaration of 2002 was taken by the President of the Security Council having consulted the Council members. We, the custodians of this document, were told to remove names of companies, supplier states and individual names before the declaration was given to the ten elected members of the Council. Dr.Hans Blix, at that time, Executive Chairman of UNMOVIC, was specifically instructed by the present Security Council to do this. Yes, I agree with you that it was contentious at the time.

Dr. Kay Mereish: You also have a question about the Executive Summary that we published, a sanitized version of another document. The compendium is not finished. We will be publishing the compendium, again, within the guidelines, by removing certain names of companies and proliferation concern issues will be eliminated.

Khalil Hashmi: This compendium will not be available to Member States?

Ewen Buchanan: The intention is to create one version that contains all the information. The second which will be made public will not contain proliferation sensitive material

or names of individuals or companies or countries. That is our intention, unless told otherwise by the Security Council. It will also be on our web site. We have a target date, the end of June.

Khalil Hashmi: I think there was an initial preparation of the compendium which was shared with the College of Commissioners and then, based on the criteria or guidelines given to you, you will be preparing a sanitized version which will be shared with Member States if the Security Council decides. If the Council decides, beyond the P5, not to share, that would be their decision.

I would encourage the NGO Committee to also look into these issues and let the international community know. Why are these names not being published? I don't think the names of individuals and companies are so sensitive. It has nothing to do with a proliferation concern. There is something else.

Ann Lakhdir: I thank you very much, Kay. I am very appreciative so many of you have come. I think Kay did a good enough job for the non-scientists like myself for us to at least partially understand what you were saying.

The transcript may be found on the web site of the NGO Committee on Disarmament, Peace and Security in color at <http://disarm.igc.org/unmobiv19april.pdf>.

Annex on the history of UNMOVIC

by Ann Lakhdir

UNMOVIC, the United Nations Monitoring, Verification and Inspection Commission, was a follow-on to UNSCOM, the United Nations Special Commission, which was created by Security Council resolution 687 of 3 April 1991. Section C of the terms of the cease fire between Iraq and the coalition of Member States co-operating with Kuwait called for the elimination, under international supervision, of Iraq's weapons of mass destruction (chemical, biological and nuclear weapons) and ballistic missiles with a range greater than 150 kilometers. UNSCOM worked with IAEA, the International Atomic Energy Agency, which focused on nuclear issues.

UNMOVIC was created by Security Council resolution 1284 of 17 December 1999. UNMOVIC continued with UNSCOM's mandate to verify Iraq's compliance with its obligation to be rid of its weapons of mass destruction and to operate a system of ongoing monitoring and verification to ascertain that Iraq does not reacquire the same weapons prohibited to it by the Security Council. The Secretary-General of the United Nations appointed Dr. Hans Blix of Sweden to be the Commission's Executive Chairman. He served from 1 March 2000 to 30 June 2003. The Secretary-General also appointed 16 individuals to serve on the College of Commissioners of UNMOVIC which provided advice and guidance to the Chairman in the execution of his duties. On 1 July 2003, the Secretary-General appointed Mr. Demetrius Perricos as Acting Executive Chairman of UNMOVIC.

Unlike UNSCOM, the staff of UNMOVIC were employees of the United Nations. In addition to the Office of the Chairman with executive, legal and liaison functions, UNMOVIC comprised four divisions: Planning and Operations, Analysis and Assessment, Information, Technical Support and Training, as well as an administrative service. UNMOVIC was headquartered at the UN in New York. The Executive Chairman was required to report to the Security Council every three months and to consult the College of Commissioners on written reports to the Council, which met at least four times a year in closed session to discuss the report and other activities. Although its inspectors were withdrawn from Iraq in March 2003, UNMOVIC continued to operate with respect to those parts of its mandate that it could implement outside of Iraq such as remote monitoring and maintained a degree of preparedness to resume work in Iraq. It maintains a roster of more than 370 experts ready to serve. Dr. Hans Blix has detailed the UNMOVIC experience in Iraq in *Disarming Iraq*, published by Pantheon Books in 2004.

On April 27 2007 Iraq sent a letter to the President of the Security Council calling for the end of UNMOVIC (S/2007/236). Iraq would like the money in the escrow account — around \$65 million — to be turned over to Iraq. On June 29 Security Council resolution 1762 (2007) was adopted 14-0-1. The operative part of the resolution:

“1. *Decides* to terminate immediately the mandates of UNMOVIC and the IAEA under the relevant resolutions;

2. *Reaffirms* Iraq’s disarmament obligations under relevant resolutions, *acknowledges* Iraq’s constitutional commitment to the non-proliferation, non-development, non-production and non-use of nuclear, chemical, and biological weapons and associated equipment, material, and technologies for use in the development, manufacture, production and use of such weapons, as well as delivery systems, and *urges* Iraq to continue to implement this commitment and to adhere to all applicable disarmament and non-proliferation treaties and related international agreements.

3. *Invites* the Government of Iraq to report to the Security Council within one year on progress made in adhering to all applicable disarmament and non-proliferation treaties and related international agreements, notably the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons, an Additional Protocol to its Safeguards Agreement, and on progress made by the National Monitoring Directorate and the Government of Iraq with regard to dual-use controls and harmonizing Iraqi export legislation with international standards;

4. *Takes* note of the summary briefings provided by UNMOVIC/UNSCOM and IAEA on their respective activities in Iraq since 1991, and *expresses* appreciation for their dedicated work;

5. *Requests* the Secretary-General to take all necessary measures to provide for the appropriate disposition of UNMOVIC’s archives and other property under arrangements ensuring, in particular, that sensitive proliferation information or information provided in confidence by Member States is kept under strict control, and further requests that the Secretary-General inform the Security Council within three months on steps taken in this regard;

6. *Requests* the Secretary-General to transfer to the Government of Iraq through the Development Fund for Iraq not later than three months from the date of this resolution, all remaining unencumbered funds in the account established pursuant to paragraph 8 (e) of resolution 986 (1995), after returning to Member States at their request contributions made by them pursuant to paragraph 4 of resolution 699 (1991);

7. *Decides* to remain actively seized of the matter.”

Attached to the resolution are two annexes, one signed by Condoleezza Rice, the Secretary of State of the US, and Margaret Beckett, Secretary of State for Foreign and Commonwealth Affairs of the UK, and the other signed by Hoshiyar Zebari, the Minister for Foreign Affairs of Iraq. The first refers to the conclusions of the Special Adviser to the US Director of the Central Intelligence Agency on Iraq’s Weapons of Mass Destruction (the “Duelfer Report”), the report of the Iraq Survey Group after visiting suspected weapons-related sites and having searched through many documents — and finding no weapons of

mass destruction. The report and its addenda are available at http://www.cia.gov/library/reports/general--reports-1/iraq_wmd_2004/index.html. Neither the US, the UK nor Iraq saw any need for UNMOVIC to conduct any investigation in Iraq before making a final report, unfortunately. Many of the sites the UN had been monitoring were looted and the explosive material and the chlorine gas has been used in terrorist attacks.

After the adoption of the resolution half the staff of UNMOVIC were given 6 working days notice and they were gone by July 10. Eight technical experts and some administrative and support staff will work until the end of July 2008 to complete the closing down of UNMOVIC, with attention to proliferation concerns and sensitive information, as described in paragraph 5 above of resolution 1762. In addition, they prepared a draft report for the Secretary-General in September 2007.

The transcript indicates some of the technical achievements of those working at UNMOVIC. It would be a huge blunder if that expertise were lost to the UN. We very much hope that at least some of the equipment and several of the experts are retained in the UN Office for Disarmament Affairs. It would greatly increase the expertise and capabilities of UNODA.

A mandate already exists for the United Nations Office for Disarmament Affairs to expand the expertise of the Office on biological weapons. On September 20, 2006, the General Assembly adopted Resolution 60/288, the United Nations Global Counter-Terrorism Strategy. The 11th measure of the resolution says:

“11. To invite the United Nations system to develop, together with Member States, a single comprehensive database on biological incidents, ensuring that it is complementary to the biocrimes database contemplated by the International Criminal Police Organization. We also encourage the Secretary-General to update procedures, available to him for the timely and efficient investigation of alleged use. In addition, we note the importance of the proposal of the Secretary-General to bring together, within the framework of the United National, the major biotechnology stakeholders, including industry, the scientific community, civil society and Governments, into a common programme aimed at ensuring the biotechnology advances are not used for terrorist or other criminal purposes but for the public good, with due respect for the basic international norms on intellectual property rights;”

That resolution permits the UN Office for Disarmament Affairs to have at present three staff members with biological expertise who previously worked for UNSCOM and/or UNMOVIC. If more funding becomes available more former UNMOVIC personnel could join UNODA.

UNODA now has a mandate to develop a single comprehensive database on biological incidents — and to update the roster of experts and laboratories. We hope the provision calling for procedures for “timely and efficient investigation of alleged use” may also make it possible to preserve some of the assets and experiences of UNMOVIC.

There has also been an updating of the procedure to be followed to authorize an investigation when there is sufficient suspicion that biological weapons may have been used.

We also believe it would be very worthwhile to propose a forum at the UN “to bring together the major biotechnology stakeholders, including industry, the scientific community, civil society and Governments, into a common programme aimed at ensuring that the public good, with due respect for the basic international norms on intellectual property rights.”

The Biological and Toxin Weapons Convention (BTWC) has no verification protocol. The present United States government maintains that the treaty cannot be verified. The presentation made by Dr. Kay Mereish indicated that with today’s technological advances it has become far more difficult to hide evidence of biological and toxin weapons from trained inspectors. The failure of the BTWC to have a verification protocol so far is the major reason many do not want to see dispersed and lost the expertise that UNMOVIC has developed. The existing General Assembly mandate cannot substitute for a verification protocol for the treaty, but hopefully that will soon be realized — and again, the expertise UNMOVIC has gained would be very useful for such a protocol.

Crucial here will be consideration of more funding for an expansion of UNODA to permit it to acquire more experts with UNMOVIC experience. Barbara Rosenberg’s proposal, can be found at <http://www.acronym.org.uk/dd/dd84/84bhr.htm>. Another proposal was presented by Trevor Findlay in December 2005 (Compliance Chronicles, Research from the Canadian Center for Treaty Compliance, Number 1, Dec. 2005: “A standing United Nations verification body, necessary and feasible”). Hopefully funding may also be provided by some governments who have a strong appreciation of the advantages of the UN keeping some of the capabilities that UNMOVIC had.

It will be a great shame if the success story of UNMOVIC — it did prevent Iraq from developing weapons of mass destruction — is forgotten. It is a demonstration of what the United Nations can do when given the opportunity. And clearly into the future similar UN-created commissions will be needed to verify the elimination of weapons of mass destruction. It is a pity that they will have to be re-created.

Towards a Global Cleanout of Nuclear Weapon Materials: Report from the International Panel on Fissile Materials

Presentation and panel discussion held on 19 October 2007 at United Nations Headquarters with Harold Feiveson, Alexander Glaser and Frank von Hippel of Princeton University and the International Panel on Fissile Materials, organized by the NGO Committee on Disarmament, Peace and Security in cooperation with the United Nations Office for Disarmament Affairs

Ann Lakhdhir (Vice President for Program, NGO Committee on Disarmament, Peace and Security): Some of you already know that the International Panel on Fissile Materials (IPFM) was founded in January 2006. It is an independent group of arms-control and nonproliferation experts from both nuclear weapon and non-nuclear weapon states.

The mission of the IPFM is to analyze the technical basis for practical and achievable policy initiatives to secure, consolidate and reduce stockpiles of highly enriched uranium (HEU) and plutonium, the key ingredients of nuclear weapons. Their control is critical to nuclear weapons disarmament, halting proliferation and ensuring that terrorists do not acquire nuclear weapons.

Both military and civilian stocks of fissile materials have to be addressed. The nuclear weapon states still have enough fissile material in their weapon stockpiles for tens of thousands of nuclear weapons. Enough civilian plutonium has been separated to make a similarly large number of weapons. Highly enriched uranium is used in civilian reactor fuel in more than one hundred locations. The total is sufficient to make about one thousand Hiroshima-type bombs, a design well within the potential capabilities of terrorist groups.

Clearly this is an untenable situation. The title Frank has chosen, "Toward a Global Cleanout of Nuclear Weapon Materials," indicates more clearly than last April's title that eliminating the large quantities of fissile material usable for nuclear weapons is a key requirement for any nuclear disarmament proposal.

IPFM research and reports are shared with international organizations, national governments and non-governmental groups. It has full panel meetings twice a year in capitals around the world in addition to specialist workshops.

Frank von Hippel, a nuclear physicist, is a Professor of Public and International Affairs at Princeton University. He has worked on fissile material policy issues for the past 30 years including those relating to commercialization of plutonium recycle, ending the production of plutonium and highly enriched uranium for weapons, and ending the use of highly enriched uranium as a reactor fuel. In 1993-4, he served as Assistant Director for National Security in the White House Office of Science and Technology Policy. He was a MacArthur Foundation Prize Fellow during 1993-8. He is currently Co-Chair of the International Panel on Fissile Materials.

Frank von Hippel: The International Panel had its fall meeting last week in London. We had copies of the 2007 Global Fissile Material Report which we distributed. We thought that this would be an opportunity to present it to interested people here at the UN and to summarize some aspects of it briefly for you. I will do the introduction and talk briefly about the chapters that my colleagues are not going to discuss. My colleague Alex Glaser will review the situation with global stocks of fissile materials, and Dr. Harold Feiveson will talk about how, if there is a renaissance of nuclear power, we should be cautious how we do it. We don't want to exacerbate the fissile material problem.

Ann has already summarized the mission of the International Panel on Fissile Materials. We have been in existence for a little less than two years. Our grant from the MacArthur Foundation is a five-years grant designed to carry us through the 2010 NPT Review Conference. We hope to contribute to a better outcome at that conference than was the case in 2005.

We have a web site. It is www.fissilematerials.org. We have issued five reports that can be found on our web site. One was the predecessor of this one, the annual report of 2006, the first half of which was pedagogical, explaining the relationships between fissile material — primarily plutonium and highly enriched uranium — and nuclear weapons. In the second half we discuss various initiatives such as the on-going efforts to end the use of highly enriched uranium, a weapons material, as a civilian reactor fuel.

We also have published reports on:

- The implications for the arms race in South Asia of the U.S.-India deal;
- Alternatives to Japan's starting up its large reprocessing plant while it still has huge stockpiles of separated plutonium which need disposition; and
- A report on the proposal by the Bush Administration to abandon a 30-year old U.S. policy and reprocess spent fuel in the United States. That is a proposal which is falling out of favor now with Congress.

Finally, we have this new report.

We have other projects in the works. We have for some time been looking at the verification issues of a Fissile Material Cut-off Treaty. You may know that the Bush Administration has declared that a FMCT would not be verifiable. In 2006 we made a presentation to the Conference on Disarmament in Geneva but we are now looking at verification issues in much more detail and hope by next spring to have an in-depth report completed.

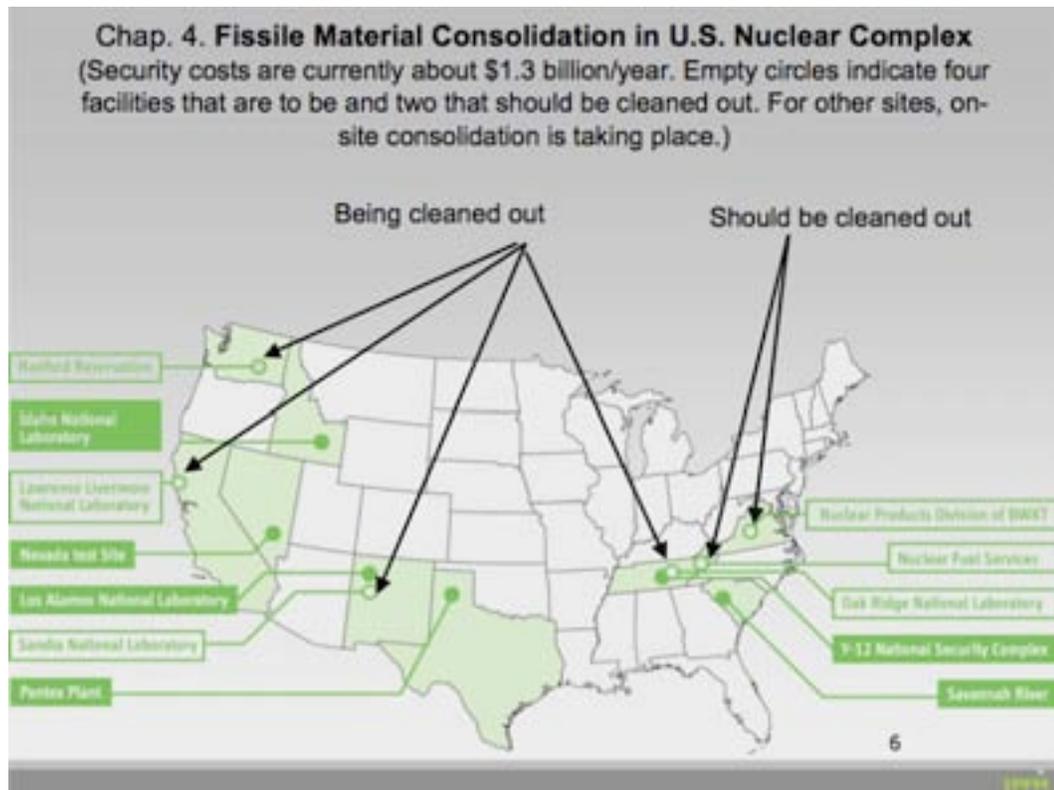
Another report in the works is on Israel's attitude toward the FMCT. There also will be a report on the elimination of HEU as a reactor fuel, and, continuing in our series, about reprocessing in France. We have a chapter in this report on the consolidation of nuclear material in the U.S. nuclear complex and we hope to have next year a report on the consolidation of nuclear materials in Russia's nuclear complex. We also have a report in the works on nuclear fuel assurances as an alternative to national enrichment plants.

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8. Russia's Nuclear-Energy Complex and its Roles as an International Supplier of Fuel Cycle Services
9. Detection of Clandestine Fissile Material production

Alex Glaser will talk about the Chapters 1-3 and 5 on issues relating to stocks of weapons and civilian materials. Harold Feiveson will talk about managing the civilian nuclear fuel cycle. I will talk briefly now about the chapters they will *not* be discussing.

Fissile material consolidation in the U.S. nuclear complex. There are at present twelve sites in this complex where fissile materials not in weapons are stored. Since 9/11, physical security requirements for these materials have increased and become much more costly. This fiscal year, the Department of Energy plans to spend \$1.3 billion on the ten sites that it has responsibility for. Even for the Department of Energy that is quite a bit of money. It has decided to clean out some sites.



The four sites that are being cleaned out include a former plutonium production site, two of the three U.S. nuclear weapons laboratories, and a nuclear energy laboratory. We focused on two additional sites that we think should be cleaned out. They produce primarily fuel for the U.S. nuclear navy and process a huge amount of highly enriched uranium. We think that all U.S. activities associated with highly enriched uranium should be consolidated in one site that is highly secured.

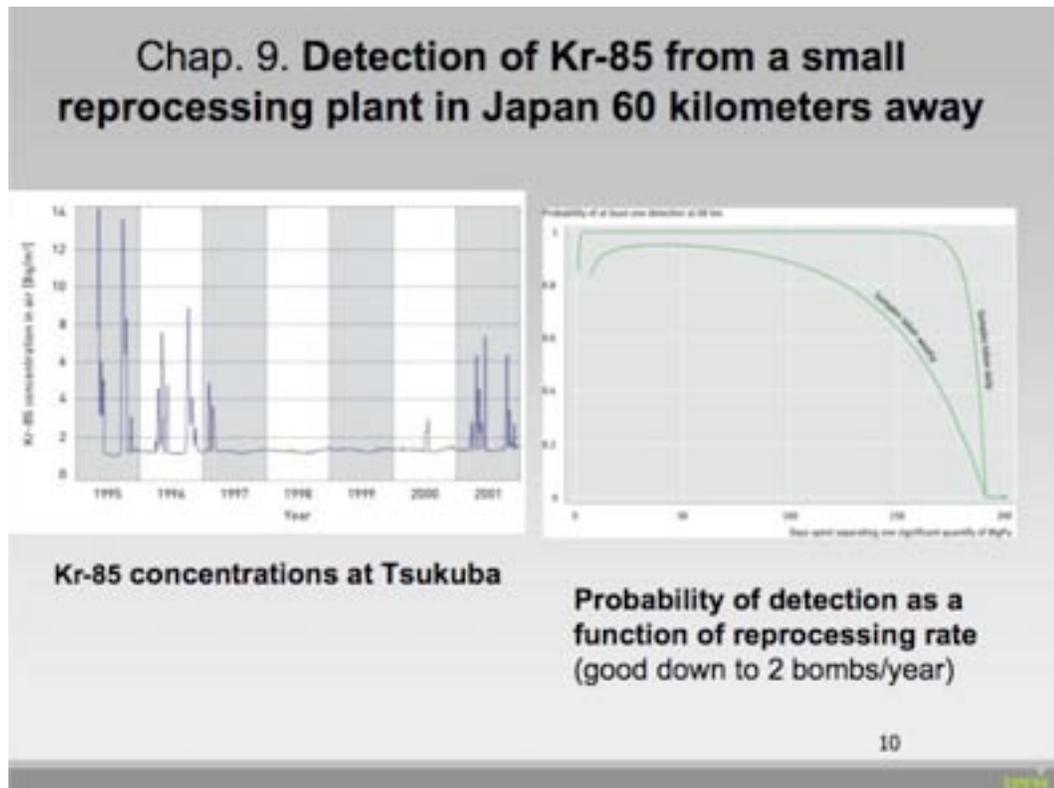
International Safeguards in the nuclear weapon States. There is also a chapter relating to the Fissile Material Cut-off Treaty. The FMCT would require IAEA safeguards to be extended to the weapons states if the treaty is verified. Quite a few of these facilities are under IAEA or EURATOM safeguards. France and the United Kingdom have declared that they have permanently ended the production of plutonium and highly enriched uranium for weapons and that therefore their enrichment and reprocessing facilities are civilian in nature. The EURATOM treaty requires that all civilian nuclear activities be under EURATOM safeguards. The IAEA has a presence in those facilities as well.

There are some other facilities. There is an enrichment plant in China that is under IAEA safeguards because it was provided by Russia and part of the agreement was that it would be under safeguards. In addition, the United States plans to build two or three centrifuge enrichment plants; and under the Hexapartite Agreement, a pact among countries including the United States that then had centrifuge facilities, it was agreed that all such plants would be under international safeguards. Whether the IAEA will actually be able to

afford to apply such safeguards remains a question. One of the issues relating to extension of international safeguards to the nuclear weapons States is the IAEA budget. We think, however, that the costs would be much less than the costs that were estimated in the 1990's when this was last seriously discussed.

Russia as a fuel-cycle-service provider. Russia has about 65% of the world's centrifuge enrichment capacity. A second large producer is Urenco, an independent, global energy and technology company with centrifuge production plants in the United Kingdom, the Netherlands and Germany. The capacity both inside and outside of Russia is increasing. While it is likely that Russia's share will decline in coming years it will remain a major supplier. There had been hope by many that Russia would become an international spent fuel storage site for countries which are having political trouble finding storage sites for their accumulating spent fuel. Russia has been importing foreign spent fuel with the intention of reprocessing it. Recently, however, Russia decided to adopt a policy like France and the United Kingdom and send back the high level waste from reprocessed spent fuel to the country of origin. The customers, like the customers of the United Kingdom and France, concluded that, if they have to store the high level waste anyway, they might as well store the unprocessed spent fuel. Russia, France and the United Kingdom therefore have lost almost all of their foreign customers for reprocessing.

The detectability of clandestine reprocessing or enrichment plants. The last chapter in the report is also related to the verification of an FMCT — and the NPT for that matter. I show here one interesting figure that shows the detection of the gaseous fission product, krypton 85, which is difficult to capture and is released by all reprocessing plants to the atmosphere.



There is a small reprocessing plant at Tokai in Japan. It is releasing krypton 85 and you see the detection 60 kilometers away. Krypton 85 has a half life of about 11 years. It accumulates in the atmosphere. The spikes are the concentrations in the plumes on top of the global background. You can see that the signals are strong. In fact one member of our group at Princeton, Scott Kemp, analyzed the detectability of reprocessing as a function of reprocessing rate and concluded that reprocessing at this site was detectable down to separation of plutonium at a rate sufficient for about two weapons a year.

Ann Lakhdhir: Now we will hear from Alex Glaser. He is on the Research Staff of Princeton's Program on Science and Global Security, joining the Program in February 2005. Previously he was associated with the Interdisciplinary Research Group in Science, Technology and Security (IANUS) of Darmstadt University of Technology, Germany. Glaser has been an adviser to the German Federal Ministry of Environment and Reactor Safety in 2000 and 2001 and has served on the Council to the Executive Board of the German Physical Society.

Alexander Glaser: Thank you. I will focus here on Chapter 1, which summarizes the stockpiles of fissile materials. But to put these numbers into context I will also briefly review the current nuclear arsenals. This will then also allow us to determine the potential for future fissile material reductions given progress in nuclear disarmament.

Nuclear Arsenals

(based on estimates by the Natural Resources Defense Council)

Country	Nuclear Warheads
United States	about 10,000 <i>(3000 deployed + 5000 in reserve)</i>
Russia	about 10,000 <i>(large uncertainty as to number awaiting dismantlement)</i>
France	348
United Kingdom	185
China	about 200
Israel	about 100
Pakistan	about 60
India	about 50
North Korea	less than 10

Global Public Relations Report 2017 - Nuclear Weapons and Public Opinion: Insights and Implications

Here are the latest estimates of the nuclear arsenals worldwide. The data has been compiled by the Nuclear Resources Defense Council and the Federation of American Scientists. The stockpiles are dominated by the United States and Russia, each having about 10,000 nuclear weapons. In the case of the United States, we know that about 5,000 of them are actively deployed, while the remainder is in active or inactive reserve. In the case of Russia, the information on the structure of the stockpile is more uncertain. The United Kingdom has made explicit statements about the total of deployed nuclear weapons which gives us confidence in this estimate. I would like to emphasize that the rest of these numbers are estimates, and it is likely that some of these numbers will change when new information becomes available.

To pick one example, for a long time, Western governments and NGOs estimated the total stockpile of China to be around 400 nuclear weapons. About a year ago, however, the U.S. Department of Defense did a reassessment and now believes that China does not deploy tactical nuclear weapons. As a result, about 200 weapons were removed from the estimate. Remarkably, China made a statement about three years ago, saying that it possesses the smallest number of nuclear weapons among the NPT nuclear weapons states, which would be roughly consistent with the information we have on the U.K. stockpile.

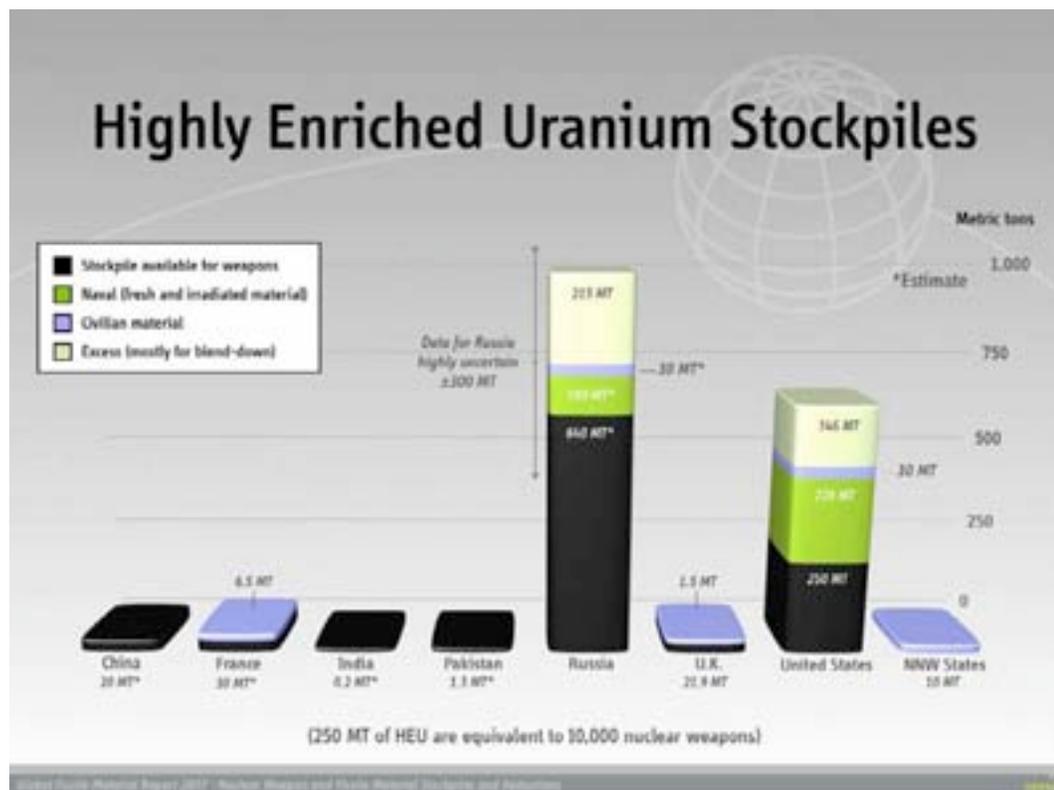
What are fissile materials? Our definition of fissile material is any material that can sustain an explosive chain reaction. For all practical purposes this would be highly enriched

uranium or plutonium in almost any isotopic combination. The IAEA uses somewhat different language.

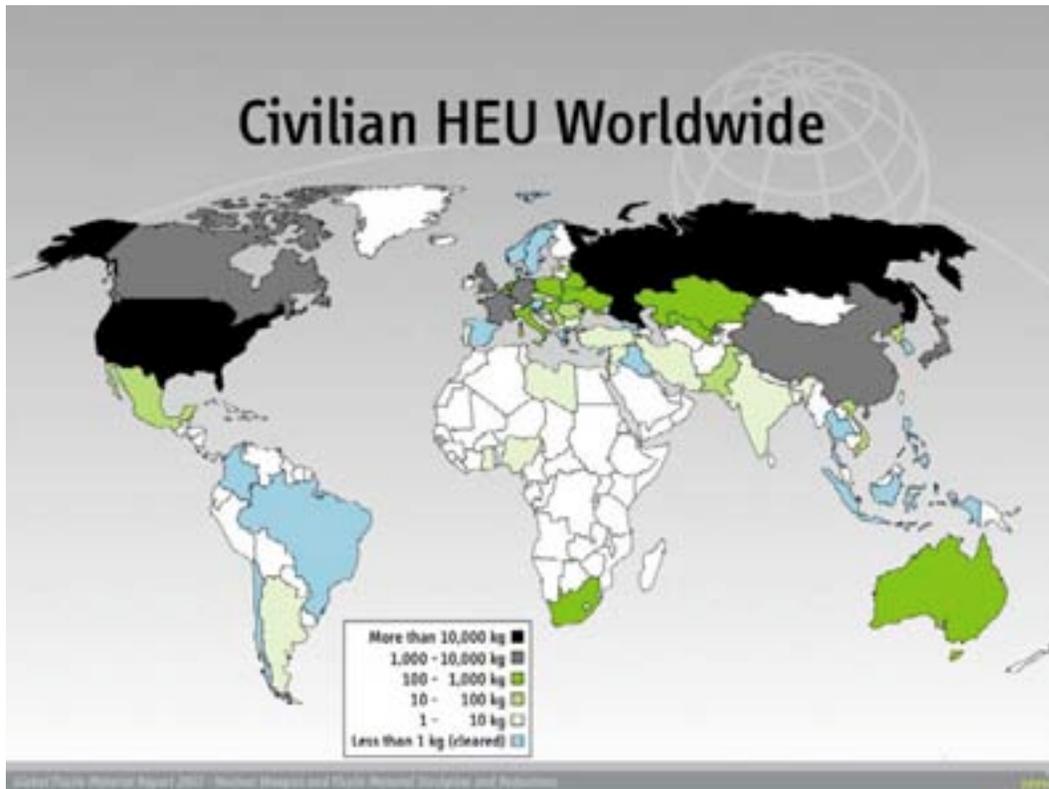
You may know that if you have a certain quantity of fissile material, a so-called critical mass, in a certain configuration, you can create an explosive chain reaction. Typically, 4-5 kilograms of plutonium or 15 kilograms of HEU are sufficient to obtain a critical mass if a neutron reflector is used.

HEU and plutonium are the essential ingredients for all nuclear weapons, ranging from simple first-generation nuclear weapons to modern thermonuclear weapons. Either HEU or plutonium is sufficient to make a nuclear weapon. Generally, however, we believe that modern nuclear warheads contain both. On average, there are about four kilograms of plutonium and 25 kilograms of HEU in a modern thermonuclear warhead.

Here is my first important slide: the global stockpile of highly enriched uranium. These are our best estimates for the global stockpiles of highly enriched uranium, and they are discussed in some detail in the report. We distinguish four categories. In black, the stockpile available for weapons and in green, the naval fuel, which is used in U.S., Russian and U.K. submarines. Blue refers to HEU for civilian use. Finally, the HEU that the United States, the United Kingdom, and Russia have declared excess to military purposes is shown in light green.



Civilian HEU worldwide. I will now address briefly the distribution of civilian HEU and the progress eliminating this use. The countries using civilian HEU are shown in this map. As many of you know, in the 1950s and 1960s many research reactors were built around the world as part of the Atoms for Peace program. Most of these reactors were fueled with highly enriched uranium. As a result, we ended up having HEU in more than 50 countries around the world. You see here the distribution as we have it today.

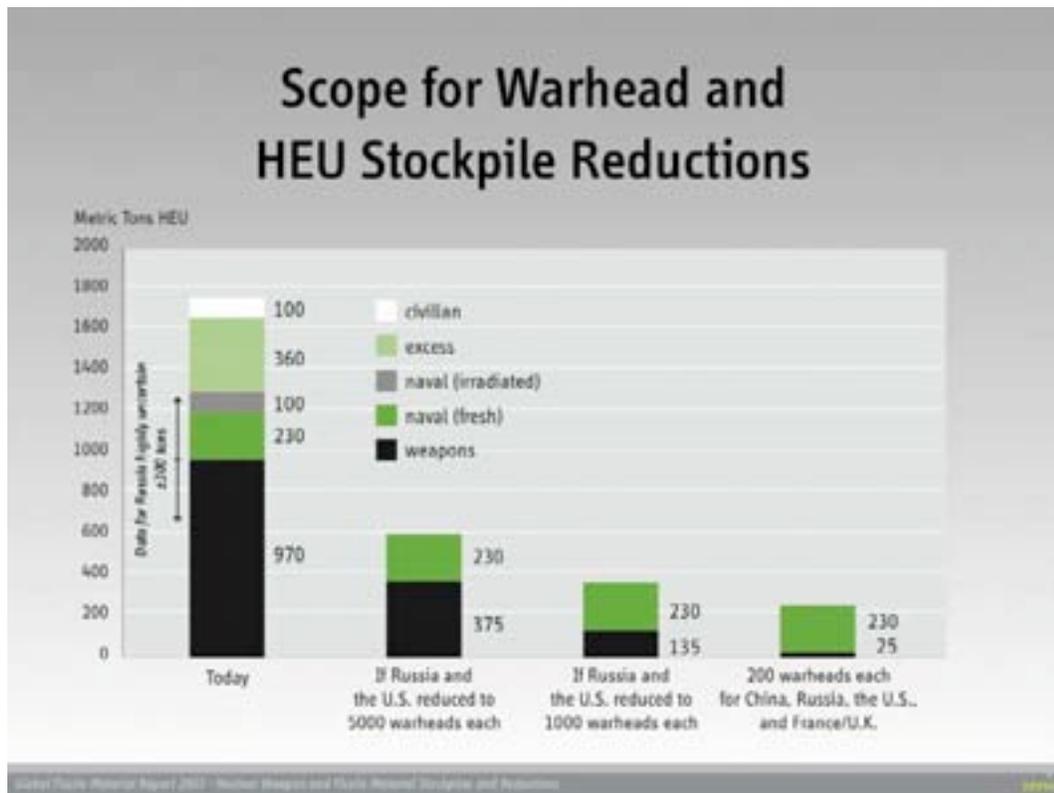


Since the late 1970s, there has been an effort to convert these research reactors to low enriched fuel and there has been significant progress in this effort, especially recently. There are still about 100 tons in the civilian nuclear fuel cycle. That is the bad news. 16 out of the 56 countries, which had HEU-fueled reactors, have had all their reactors converted, or shut down in some cases and all civilian HEU removed. Today there remain about 130 HEU-fueled research reactors. The program has accelerated recently and the annual rate is now between 5 and 6 reactors converted every year. Historically, it was more like 1 or 2 a year, so that is the good news. Roughly half, about 70, of the reactors that have not been converted are in Russia. To get Russia on board therefore would make a significant difference in these efforts to clean out civilian HEU.

Disposing of excess HEU. I mentioned progress in disposing of excess HEU from the Russian and the U.S. stockpiles. Most important is the so-called Russian-U.S. HEU deal, to blend down 500 metric tons of Russian HEU to LEU and to sell it as reactor fuel. Almost

300 metric tons have been blended down so far and 200 more are remaining. The rate of blend-down is 30 tons per year. The United States has blended down about 90 tons of its HEU thus far, but this material was less than weapon-grade, and did not come from nuclear weapons. If we adjust for enrichment, it is equivalent to about 50 tons of weapon-grade uranium. The rate is about 5 tons per year. One problem is that there may not be a follow-up agreement or effort to continue blending down excess Russian HEU once the current deal expires in about 6 years.

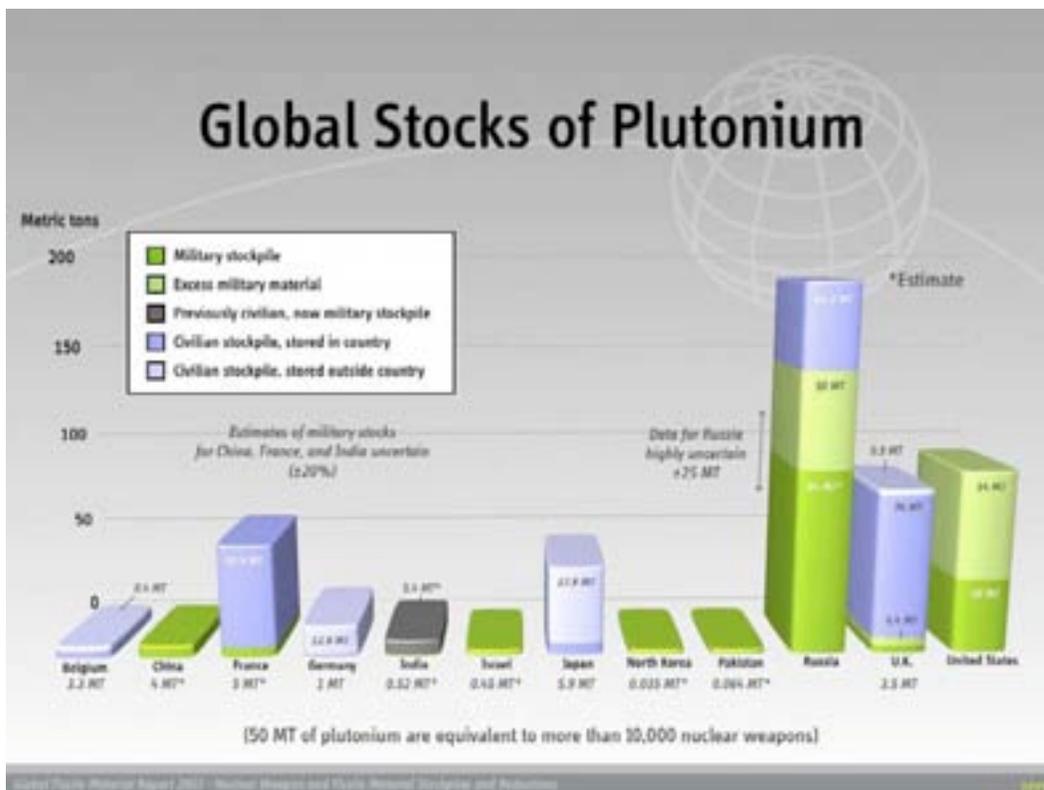
Scope for warhead and HEU stockpile reductions. The left-most bar in the next figure illustrates the situation today. The other bars show how this will evolve when nuclear disarmament proceeds. We do not show the civilian HEU in the scenarios because we hope it will be cleaned out and blended down sooner rather than later. We have also excluded the HEU that has been declared surplus because it will be blended down. Finally, we exclude the HEU in U.S. irradiated naval fuel because it will probably be disposed of without reprocessing. So, the HEU other than that reserved for weapons that is relevant for the long term is that reserved for naval reactor fuel.



As I mentioned, the United States, Russia and the United Kingdom are fueling submarines with HEU and have set aside HEU for this purpose. As you see, once we go down to 5,000 warheads each for Russia and the U.S. — basically the level implied by the Strategic Offensive Reduction Treaty between the United States and Russia, which calls for 2200 *deployed* strategic weapons by each side by 2012 — the 230 metric tons of HEU reserved

for naval fuel becomes a very substantial portion of the stockpile. If we go beyond SORT to 1000 warheads each or even to deeper cuts, with 800 warheads for all the nuclear weapons states, the naval stockpile overshadows the material that is actually reserved for weapons. At that point, the naval fuel reserves could become a serious problem and might cause some countries to be very reluctant to pursue further negotiations on nuclear weapons reductions.

Global stocks of plutonium. The global stocks of plutonium fall into several categories. The dark green in the bars in the next figure are the military stockpiles. We have material declared excess in the cases of Russia, the United Kingdom and the United States. We have previously civilian material that India has now re-labeled military, and then we have the civilian stockpile in blue. Again, in many cases, these are estimates. In the case of Russia especially, the uncertainties make a significant difference: an uncertainty of 25 tons correspond to an equivalent of 5000 nuclear weapons. As with HEU, military production of plutonium has been stopped in the nuclear weapons states in the NPT; it continues in Pakistan and India and probably in Israel. It also continues in Russia as an unwanted “byproduct” of its remaining plutonium-production reactors, but these will hopefully be shut down soon.

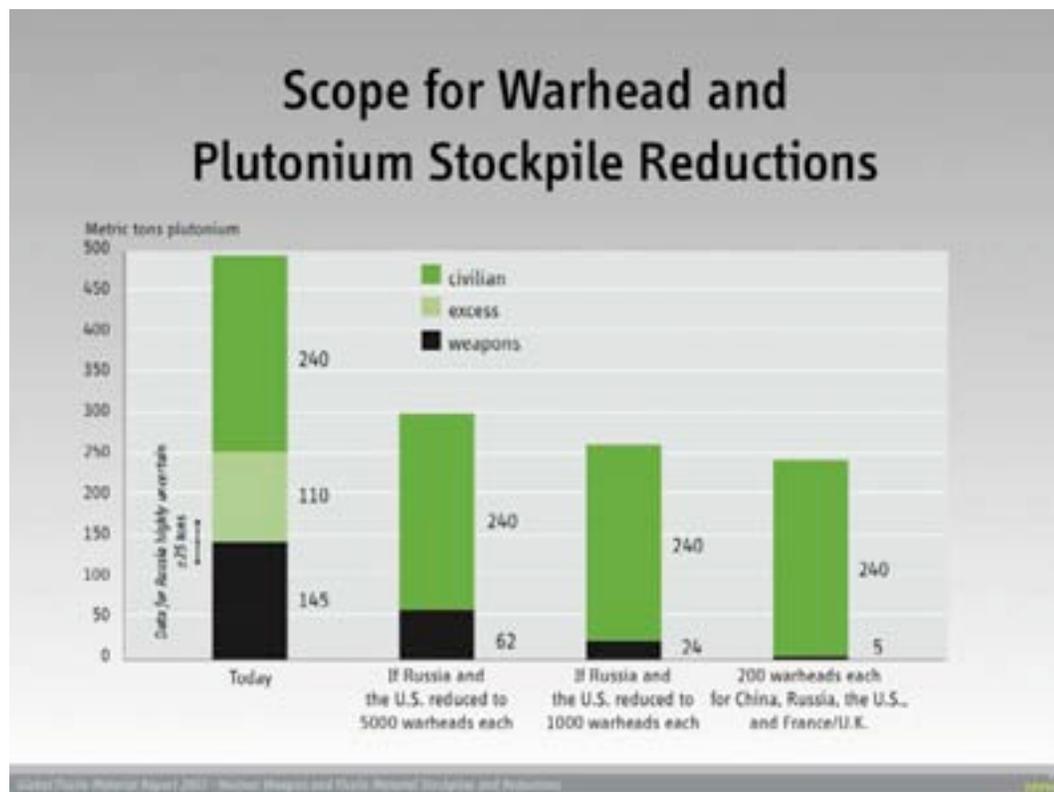


The re-labeling of India’s civilian plutonium is a consequence of the U.S.-India deal, under which India excluded international safeguards on most of its existing plutonium stockpile. More generally in South Asia, the really disturbing thing in the plutonium picture

is the new production potential. The Indian prototype fast breeder reactor, which will be completed in 2-3 years, will produce more than 140 kilograms of weapon-grade plutonium per year. This material is to be outside international safeguards. If used for the weapons program this would correspond to a five-fold increase of India's production rate of weapon-grade plutonium. We did some analysis in Princeton and concluded that it will be indeed quite tempting to do it because, for some reactor specific reasons, it would be convenient to withdraw the weapon-grade plutonium from the blanket and not recycle it back into the reactor. In addition, two new plutonium production reactors are under construction in Pakistan. These reactors, Khushab II and III, would at least triple Pakistan's plutonium production rate in the future.

Scope for warhead and plutonium stockpile reductions. In the case of HEU, the big open question was the naval fuel. In the case of plutonium, the equivalent is the civilian stocks, which are very large and growing. Japan has now opened a new reprocessing plant that will sustain this trend for at least some years.

The civilian stockpile of plutonium already equals the military stockpile today. Even if we assume that the excess military material will be disposed of and that we will not need to take it into account in the future, you will see that in the 5,000-warhead SORT scenario, and especially in the other scenarios, the civilian stockpiles will overwhelm the military stockpiles of plutonium.



One can argue that most of the civilian material is under safeguards, so it is somewhat less relevant. Yet, these 240 tons of civilian plutonium can't and won't be ignored in future arms reduction negotiations. I hope this chart makes clear that there is an urgent need to bring down these civilian stockpiles, and at least stop producing new plutonium before one can feed it back into the nuclear fuel cycle. I think Hal Feiveson will talk about this in a moment.

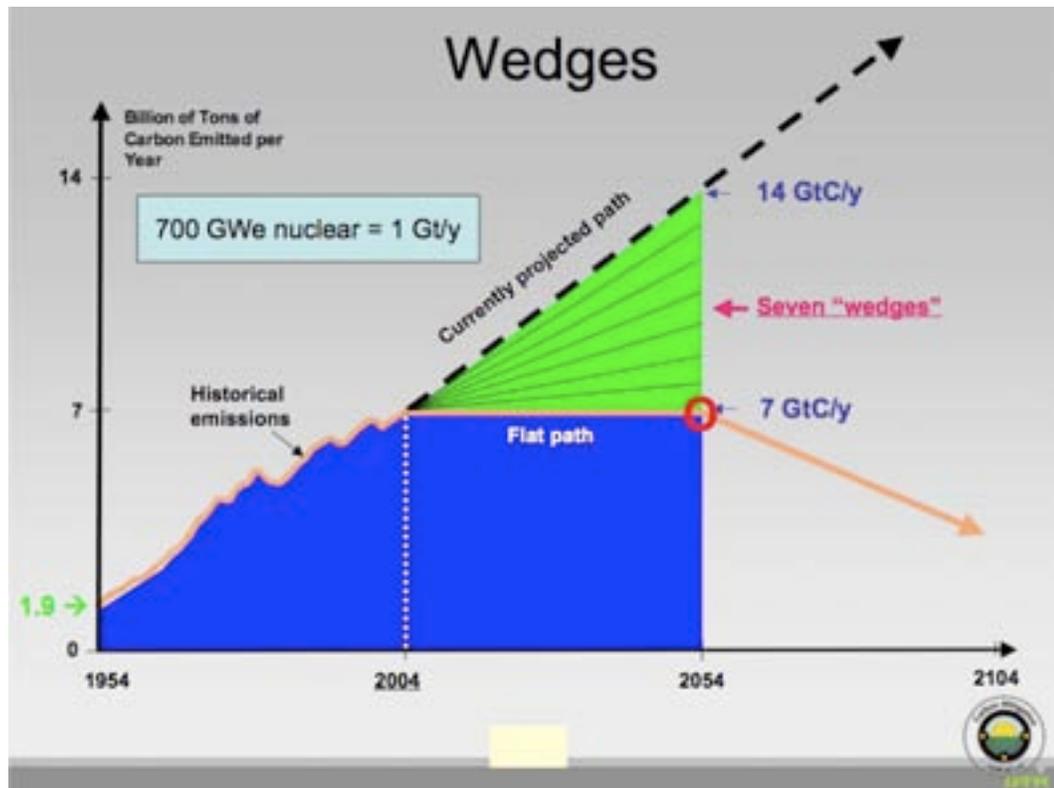
Conclusion. The existing fissile materials stockpiles are still dominated by Russia and the United States. The stockpiles reserved for weapons purposes are still tremendous — large enough for 20,000 to 40,000 nuclear weapons — which essentially means one could go back to Cold War levels. We have made much less progress than we anticipated in the 1990s. Related to that, the disposition of excess stocks has been much slower than we expected, with the exception of the Russian HEU down-blending. Very little of the excess plutonium has been disposed of so far. And as I just outlined, there is a new fissile material arms race unfolding in South Asia. It will not have a great impact on the global stocks of fissile materials, but the impact in South Asia could be quite dramatic.

One roadblock to deep cuts in nuclear weapons and fissile materials are, one, there is a great uncertainty in some of the inventories — especially Russia's. The uncertainty is equivalent to tens of thousands of nuclear weapons. It would really help if we had more detailed information and more transparency of the existing stocks. The United Kingdom and the United States have set good examples in declaring their holdings of HEU and plutonium, which shows that such declarations can be made with no dramatic adverse security impacts.

Finally, naval HEU and the growing civilian plutonium stockpiles could at some point become serious obstacles to further reductions in stockpiles of fissile materials, and eventually also of nuclear weapons. Thank you.

Ann Lakhdir: Next we will hear from Harold Feiveson. He is Senior Research Scientist and Lecturer in Princeton University's Woodrow Wilson School. He was formerly Co-Director of Princeton's Program on Science and Global Security with Frank von Hippel. His recent work has focused on the ways in which the nuclear arsenals of the United States and the former Soviet Union can be dismantled and "de-alerted" and the strengthening of the separation between nuclear weapons and civilian nuclear energy activities. He is also the editor of the journal, *Science & Global Security*.

Harold Feiveson: Frank referred to Chapter 7, "Managing the Civilian Nuclear-Fuel Cycle," by myself, José Goldemberg and M.V. Ramana, in our 2007 Report. I am going to focus on just one aspect of the chapter, but I want to start with two graphs that were not in the chapter. They were done by colleagues of ours at Princeton. The first, by Robert Socolow and Stephen Pacala, sets the stage on how to think about nuclear power and global warming. It is the hope of the nuclear industry that climate change will impel a renaissance in nuclear power.



Today, the global economy emits about 7 billion tons (gigatons) of carbon in carbon dioxide. If we want to stabilize the carbon-dioxide concentration in the atmosphere at no more than twice the pre-industrial level, we would have to more or less level off at the present level of 7 gigatons per year. Business as usual, as projected by the International Panel on Climate Change, takes us to 14 billion tons per year in 50 years. So, we have to figure a way to reduce carbon emissions by 7 billion tons a year by 2050.

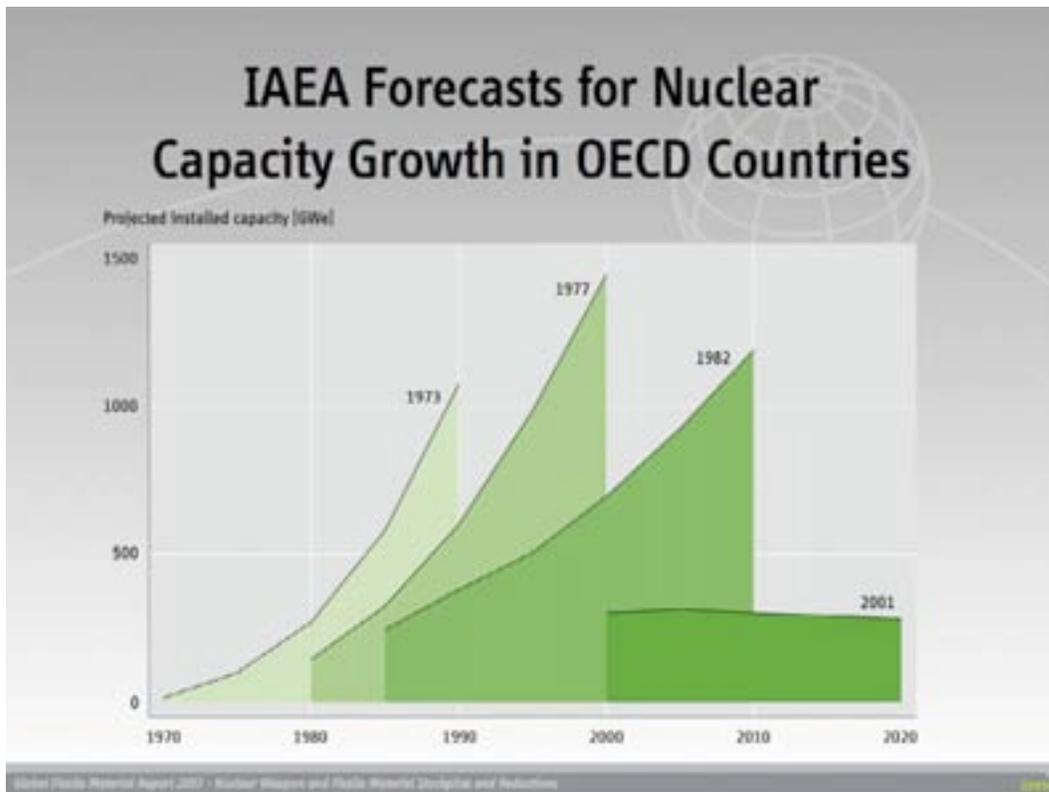
For nuclear to make up one seventh of that savings — that is, one gigaton per year — it would have to roughly triple its present capacity of 370 gigawatts to something over one thousand gigawatts. Seven hundred gigawatts of new nuclear capacity could save one gigaton of carbon per year if it replaced 700 gigawatts of modern coal plants.

Another colleague of ours at Princeton, Robert H. Williams, showed that if there were a charge on carbon on the order of \$100 a ton, there are alternatives that would be roughly comparable in cost to nuclear. Among these are, for example, integrated gasification combined cycle (IGCC) with carbon capture and storage (CCS), which would be about equally expensive as nuclear energy at a production cost of about nine cents per kilowatt hour.

Nuclear-growth projections. For the rest of my comments, I want to focus more modestly on projections for the next quarter century. Most projections for this period show

today's 370 gigawatts of nuclear generating capacity growing to 400-500 gigawatts by 2030.

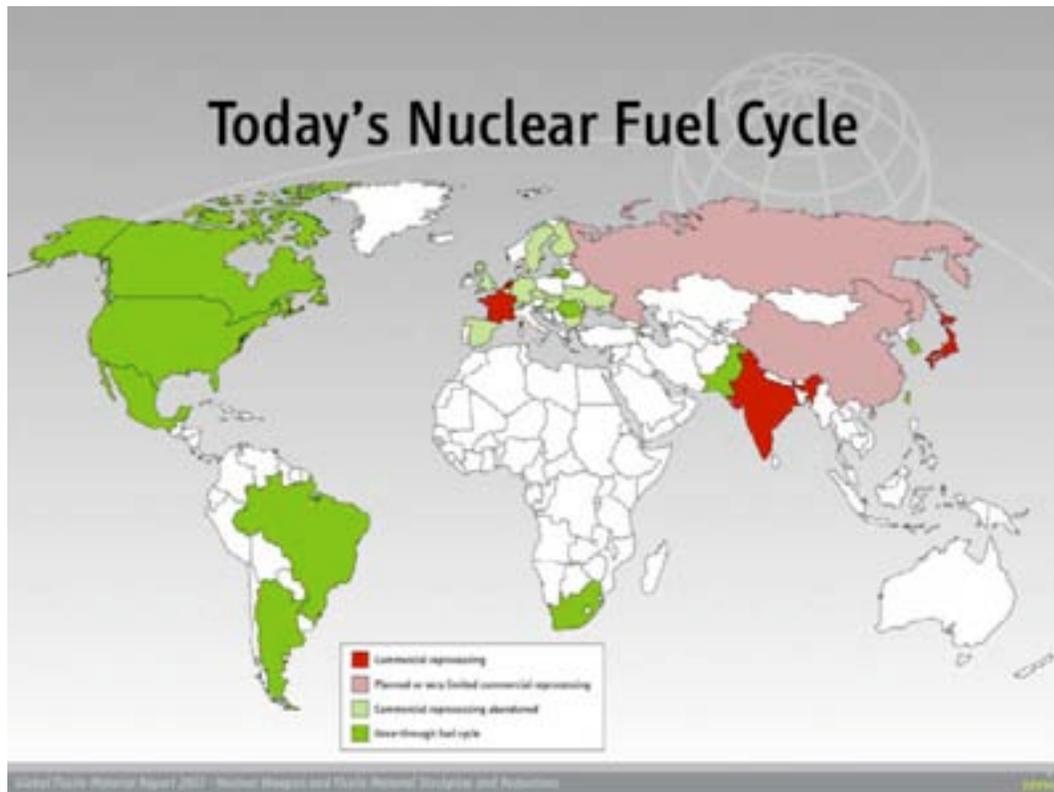
The next slide provides a good cautionary tale — projections made by the International Atomic Energy Agency in the various years indicated. In 1973, the IAEA was projecting a thousand gigawatts global capacity by 1990. In 1977, it projected something close to 1500 gigawatts by the year 2000, and so on. But in 2001, the IAEA became more cautious, and its projection then was basically that nuclear power will be flat for a long period. Last year, the IAEA did become more optimistic, but only slightly so.



However, even if there is little growth in installed nuclear power, there is going to be a problem of uranium enrichment. As was indicated, there will be a growing centrifuge uranium capacity. There is a proliferation risk with the spread of centrifuge capacity.

And then there is the question of what to do with the spent fuel. The next map shows basically four different paths of what countries are doing with spent fuel. The green are the countries using a once through fuel cycle. In other words, spent fuel is not reprocessed and no plutonium separated. The pink-tinged countries are those countries with limited reprocessing activities or plans. These are China and Russia. China has indicated future plans to reprocess, and Russia reprocesses only a small fraction of its spent fuel. The serious reprocessors are shown in red: Japan, India, and France. The countries shown in light green

are those that did reprocess at one time, but now have either abandoned reprocessing or are about to.



Spent-fuel management. There are three fundamental choices on how to handle spent fuel. In the once-through fuel cycle currently used by the United States, the spent fuel is kept in pools of water or in dry casks and not reprocessed. The second approach is what is done in France, and what the Japanese plan to do. The spent fuel is reprocessed, the plutonium is separated, and then turned into mixed-oxide fuel, uranium/plutonium fuel, which is then recycled into light-water reactors. The spent mixed-oxide fuel is not reprocessed any further. It is kept in storage. This scheme is much more complicated than the once through fuel cycle, and it is more expensive.

The third scheme is what the U.S. Department of Energy proposed last year. In this scheme, the so-called Global Nuclear Energy Partnership (GNEP), after the spent fuel is sent to the reprocessing plant, not only are the plutonium and uranium separated from the fission products, but also the other transuranics, curium, neptunium, and americium. All those transuranics, including the plutonium, are then recycled in fuel for a fleet of fast reactors, with repeated recycling going on for perhaps a hundred years before the transuranics are largely burned down. The fission products would then be put into a geological repository, like Yucca Mountain. This would allow the radioactive waste from much more spent fuel to be put into the repository than if the spent fuel were put in without the reprocessing and recycle into the fast reactors. That seems to be driving the interest in GNEP. It would allow

the capacity of Yucca Mountain to be increased five-fold to maybe fifty-fold. However, to burn up the transuranics produced by the hundred gigawatts light-water reactor capacity that the United States has today would require something like 40 to maybe 75 gigawatts of fast-reactor capacity. This is very expensive and U.S. utilities have made clear that they will not pay for the fast reactors or reprocessing.

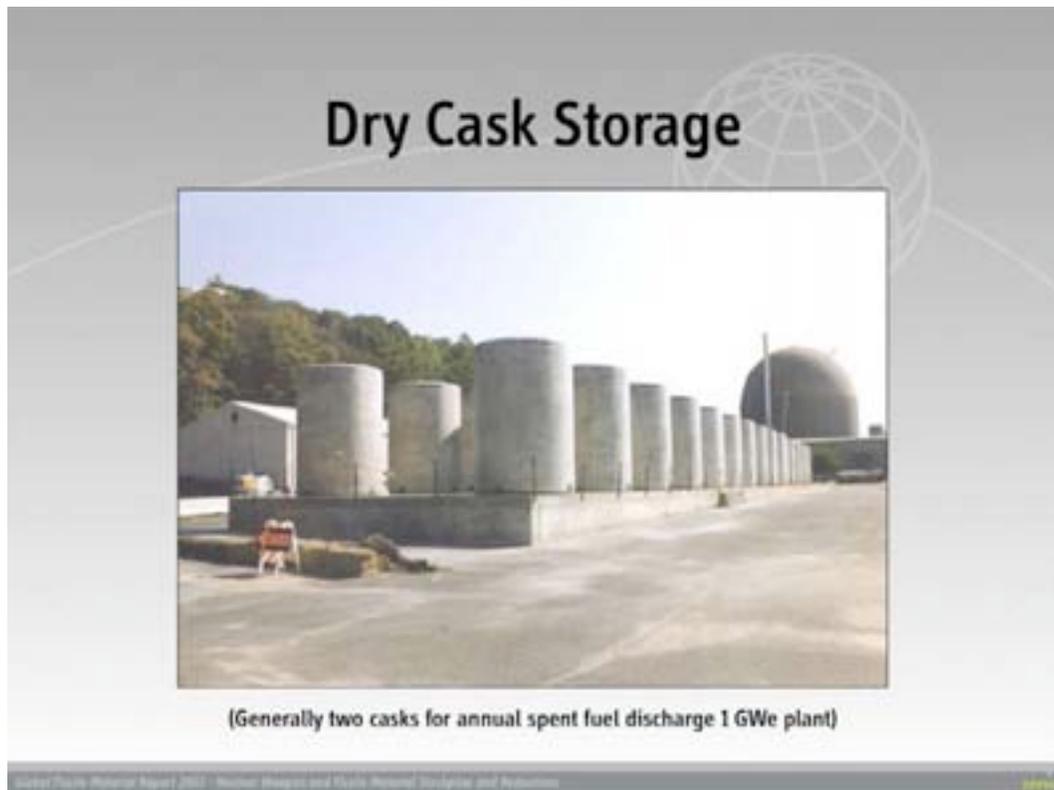
It must be emphasized that the reprocessing doesn't do any good unless you burn up the transuranics in the fast reactors. Secondly, to get the large advantage that GNEP hopes to get in increasing the useful life of the Yucca Mountain repository, the fission products, and particularly the cesium-137 and the strontium-90, have to be stored above ground for hundreds of years. It seems a little odd to replace interim surface storage of the spent fuel with interim surface storage of the separated fission products for hundreds of years. Finally, there has been a recent study by the Electric Power Research Institute that indicates that the Yucca Mountain capacity for spent fuel is far greater than the present legal limit of 70 thousand tons — perhaps as high as 260 to 570 thousand tons — 2 to 5 times more than required by the current generation of U.S. nuclear power reactors.

The reason one worries about the GNEP scheme is that it puts into play separated plutonium. Between 5 and 10 kilograms of reactor-grade plutonium would be enough for one weapon. In one ton of spent fuel from a light-water reactor, 10 kilograms of plutonium are mixed with highly radioactive fission products. It would almost impossible for a terrorist group to steal the spent fuel and extract the plutonium. Once the plutonium is separated from the fission products and uranium, however, it would be far easier.

The conclusion, looking at the back end of the fuel cycle, is that recycling plutonium once is expensive. It also doesn't save any repository space, and it doesn't save much uranium. It does not save repository space because the spent mixed-oxide fuel, which is not reprocessed, is much hotter than the light-water reactor spent fuel. And it is the heat that determines how much space is needed for a repository.

The GNEP scheme is *extremely* expensive and complex. As noted, it calls for the deployment of a fleet of fast reactors, and the storage of the radioactive cesium and strontium isotopes above ground for hundreds of years. And, by separating plutonium, it adds unnecessary dangers to the nuclear fuel cycle.

So why reprocess at all given that there is an excellent and available alternative — dry cask storage? After a period of some 15 or 20 years during which the reactor's spent fuel sits in a pool of water, the spent fuel can be put into dry casks at the reactor-site where it would be safe and secure for 50 to 100 years. Below is a picture of a dry cast storage facility. Each one of these cylinders would hold about half of the spent fuel discharged in an average reactor year. The main concern with such storage is when the reactor is decommissioned. In this case, it would be good to remove the casks to some kind of centralized or regional storage.



Panel discussion

Frank von Hippel: I would like to add to that. These dry casks are quite robust. On our scale of safety concerns, the hazard is much less than from the fuel in the reactors or their storage pools.

Randy Rydell: Over the years one of the great initiatives to discourage reprocessing has been the availability of sites for long-term storage of spent fuel. Various proposals have been floated for an island in the Pacific, Kazakhstan, Russia, China, or Chile, and other places have been talked about. In each instance it has run into terrible political opposition, environmental concerns, transportation concerns. I would like to know where this stands right now, in terms of the prospects for international spent fuel storage, and number two, how do you assess the risks of that, as compared with the risks of reprocessing?

Frank von Hippel: This response is my own, not that of the International Panel. As you say, there is such a phobia of spent fuel that the concept of some kind of regional or international storage has not gotten very far. There had been some hope that Russia would break the impasse and provide an international spent fuel storage site. But there is opposition in Russia too. I think it is not a crisis, in the sense that this dry cask storage option is available. I think we need to have a debate on how to handle spent fuel and we have

to come to a conclusion, but we do have time for this debate. Eventually it should be in a centralized repository.

Reprocessing is a way to kick this ball down the road — a way to get spent fuel off reactor site to someplace else. But it is also a temporary solution, the radioactive waste is still above ground and that is not a satisfactory solution either. The countries that do reprocess will still have to find a place that will accept an underground repository for the results of the reprocessing. It is still just a delaying maneuver.

With regard to your question, I once went to an environmental conference and said I would much rather have 6 kilograms of plutonium in the water supply than someone running off and making a bomb out of it. It did not make me more popular there, but in fact, the consequences would be much less if we drank this plutonium than if somebody made a bomb out of it. Separating plutonium is much more dangerous than continuing to store it in the spent fuel.

Harold Feiveson: I would just underline one thing Frank said, Randy. Reprocessing does not solve the spent fuel problem. It just kicks it down the road. A second thing to emphasize is that, after the Ford and Carter Administrations stopped U.S. reprocessing activities, although France and the United Kingdom continued, no country that had not already embarked on civilian reprocessing before the United States made its decision has started to do so since. And several countries that were thinking about reprocessing, such as South Korea and Taiwan — or even had fledgling reprocessing programs in place, such as Belgium and Germany, ended their programs.

Myles Ren: What has been done to secure some of the stocks of HEU and plutonium that are mentioned in the report?

Frank von Hippel: In the report we emphasize the need to reduce and, when possible, eliminate fissile materials. But you are quite right: in the meantime it has to be secured. A colleague of ours, Matthew Bunn at Harvard puts out an annual report about the programs that are devoted to making fissile material more secure around the world. This is a complementary effort to ours.

Harold Feiveson: The consolidation chapter also talks about security of stocks in the United States.

Frank von Hippel: The U.S. Department of Energy spends \$1.3 billion a year on just securing nuclear material at its ten sites. That is much more than any other country spends on fissile material security. I think there would be a lot more consolidation around the world if other countries adopted similar security standards. Countries also should understand that it makes sense to go for low-enriched uranium instead of highly enriched uranium. Already, research reactors around the world are converting to the use of low-enriched uranium fuel. We would like to interest the nuclear navies into converting to low-enriched uranium as well because they use huge amounts of highly enriched uranium.

Shivpal Vansadia: There have been reports that India is going to use thorium as a source of nuclear fuel. Is that a threat?

Frank von Hippel: The world's reactors today operate primarily on uranium-235, which is a natural chain-reacting isotope. When there were expectations that nuclear power would grow much faster than it actually has, there were fears that we would run out of low-cost uranium, and we would have to use uranium more efficiently. The dominant response to that was, well let's have plutonium breeder reactors, which can make chain-reacting plutonium out of the non-chain reacting 99.3% uranium-238 in natural uranium. Of course plutonium is a weapon material. It turned out that nuclear power did not grow that fast, and so we are not running out of low-cost uranium.

There is another alternative. You can also use thorium, which is not chain-reacting but can be used in a breeder reactor to make uranium-233, which is a chain-reacting isotope. India has a lot of thorium and does not have much low-cost uranium — at least that it has located. Also, India's lack of uranium resources is exacerbated by its isolation from the world's uranium market as a result of it using civilian plutonium in a weapon test in 1974. We are pretty critical of the U.S.-India nuclear deal because it does not stop the build-up of nuclear weapon materials in South Asia. But if it were part of the deal that India and Pakistan join the moratorium on the production of fissile materials for weapons, then having access to the world uranium market would put India in the same situation as the rest of the world. There is plenty of uranium for a hundred years. India would have no need to go the thorium route, which is much more expensive.

Ann Lakhdir: I have two questions. Nobody has mentioned Iran. I wonder what your view is of what Iran is trying to do, and maybe more importantly, what you see as a possible compromise solution. My other question, and I was noting your change of title from last April, and it seemed to me that that may have been partly reflecting the responses last year, that this wouldn't lead to nuclear disarmament. It seems to me the work you are doing is going to be critical for any nuclear disarmament treaty.

Frank von Hippel: We are of course talking about disarmament. Getting rid of fissile material is a way to make disarmament irreversible. It also makes nuclear terrorism less likely. It also makes proliferation of nuclear materials less likely. We, like many people, have broken our lances on the Iran problem. I was involved with a group that tried to look for a middle course and it was rejected by both sides. The central issue of course is the enrichment plant in Iran and alternatives to it. Iran has said that it cannot rely on external sources of enriched uranium. One idea that some of us have raised repeatedly is that you can buy your fuel five or ten years in advance. You can secure your situation for at least that length of time. But our Iranian colleagues never wished to pursue that proposal.

Newton Bowles: To follow up on Ann's question on Iran — how does the International Panel relate to the IAEA in general?

Frank von Hippel: We have no formal relationship. The IAEA did host our meeting a year ago. We have recruited retired IAEA experts to do reports for us — for instance on how to make less costly the verification of an FMCT at reprocessing plants and on the trilateral proposal of how the IAEA could monitor plutonium that is in classified form unobtrusively, without revealing design information. It is an informal but positive relationship I think.

Harold Feiveson: Iran is justifying its centrifuge plant, on the grounds that they are having some nuclear reactors and they are going to want an independent source for low-enriched uranium. In this regard, it is sobering to consider the other countries in a robust nuclear future which could argue as Iran does now. In 2003, a group at MIT developed a scenario in which the nuclear capacity of the world in 50 years increased roughly four-fold from today. Among the countries then expected to have some nuclear power, and which today have none or a negligible amount, are Algeria, Armenia, Azerbaijan, Belarus, Georgia, Indonesia, Iran, North Korea, Malaysia, Pakistan (which has some now), the Philippines, Poland, Thailand, Turkey, Turkmenistan, Uzbekistan, Venezuela, and Vietnam. You can see that, if nuclear power grows, if we are not careful how we structure the international safeguards system and figure out what to do about centrifuge plants, there are going to be a lot of “Irans.”

Ann Lakhdir: Does that mean then that you are looking at the capabilities of the IAEA to verify that nuclear material is not being used for weapons?

Harold Feiveson: It is not just technical safeguards. It is what kind of institutional structures do you want. For example, should all future centrifuge plants be multinational? Can you develop structures so that countries will feel comfortable with fuel coming from commercial enrichment facilities and so would not feel a need to build their own centrifuge plants? Plus, along the lines of your question, if you do have a centrifuge plant, how effectively can it be safeguarded? Alex is working on that in particular.

Frank von Hippel: Thank you very much for coming.

Appendix

Background information on the International Panel on Fissile Materials

The International Panel on Fissile Materials was established in January 2006 with a MacArthur Foundation 5-year grant. Its Mission is to help inform international policy on methods to:

- Achieve irreversible nuclear-warhead reductions,
- Strengthen the nonproliferation regimes, and
- Reduce dangers of nuclear terrorism.

Complete Reports (available at www.fissilematerials.org):

Global Fissile Material Report 2006 (September 2006)

Fissile Materials in South Asia: The Implications of the U.S.-India Nuclear Deal

Zia Mian, A.H. Nayar, R.Rajaraman, and M.V. Ramana (July 2006)

Japan's Spent Fuel and Plutonium Management Challenges

Tadahiro Kasuta and Tatsujiro Suzuki (September 2006)

Managing Spent Fuel in the United States: The Illogic of Reprocessing

Frank von Hippel (January 2007)

Global Fissile Material Report 2007 (October 2007)

Forthcoming Reports:

A Verified Fissile Material Cut-off Treaty

A draft treaty, Arend Meerburg

Verification in weapon-state reprocessing plants, Shirley Johnson

International monitoring of nuclear-weapon components, Thomas Shea

Israel and the FMCT, Avner Cohen and Marvin Miller

Toward the Elimination of HEU as a Reactor Fuel, Ole Reistad, Morten Bremer Maerli,
and Styrkaar Hustveit

Reprocessing in France, Yves Marignac and Mycle Schneider

Consolidation of Nuclear Materials in Russia, Pavel Podvig

Nuclear Fuel Assurances as an Alternative to National Enrichment Plants,
Chaim Braun

Members are from Brazil, France, Germany, India, South Korea, Japan, Mexico, Netherlands, Norway, Pakistan, Russia, South Africa, Sweden, the United Kingdom and the United States.

Anatoli Diakov (Moscow, Russia), is Professor Physics at the Moscow Institute of Physics and Technology and Director of its Center for Arms Control, Energy and Environmental Studies.

Jean du Preez (citizen of South Africa) is Director of the International Organization and Non-proliferation Program of the Monterey Institute for International Studies' Center for Non-proliferation Studies. He served in the South African Ministry of Foreign Affairs for 17 years, including as Deputy-Director for Non-proliferation and disarmament.

José Goldemberg (São Paulo, Brazil) has a PhD in nuclear physics. While Brazil's Minister for Science and Technology he persuaded President Collor de Mello to end Brazil's nuclear-weapon program, which led Argentina to shut its program down as well, under monitoring by a joint Argentine-Brazil inspectorate. He is best known for his work on global energy and environment issues. In 2007 he has been appointed to a super-ministerial position in the state of Sao Paulo to oversee expansion of its program to produce sugar-cane ethanol as a substitute for gasoline.

Pervez Hoodbhoy (Islamabad, Pakistan, shared membership with Nayyar) is a Professor as well as the Chair of the Physics Department at Quaid-e-Azam University, Islamabad.

Martin B. Kalinowski (Hamburg, Germany, shared membership with Schaper) is Professor of Science and Peace Research and Director of the Carl-Friedrich von Weizsäcker Center for Science and Peace Research at the University of Hamburg, Germany.

Jungmin Kang (Seoul, South Korea) has a PhD in Nuclear Engineering from Tokyo University and is currently a Research Fellow at Stanford University's Center for International Security and Arms Control.

Li Bin (Beijing, China shared membership with Shen) is a Professor of International Studies and Director of the Arms Control Program at the Institute of International Studies at Tsinghua University.

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