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Role of nuclear material accounting and control in the NPT

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I am supposed to talk about the role of nuclear material accounting and control in the Non-Proliferation Treaty - a pretty dry title. So I am going to try and liven it up a little bit, if that is possible. I am not going to go over the basics, since I assume everyone is familiar with a lot of the basic issues, and instead focus on some of my pet peeves with this issue and some current topics, about which you may not be aware.

Quickly, I will give a few definitions, because some of the terms that are floating around are extremely confusing. They change one or two letters and the meaning changes. Then I will be looking for the P in MA&C, which is Material Accounting and Control. Then I will talk about the goals and limitations of material accountancy, which is not the same as material accounting. And then I will address some applied problems with material accountancy, first in non-weapons states and then in weapons-states. And finally I will talk about integrated safeguards, which is a very dangerous development in the International Atomic Energy Agency (IAEA).

First of all, definitions. The goal of safeguards under the NPT is "the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities." This is the famous quote from INFCIRC/153, which is the safeguards agreement for most non-nuclear weapons states. In that statement, of course, the words "timely detection," "diversion," "significant quantities," "nuclear material," and "peaceful nuclear activities" are all subject to interpretation. The cornerstone of IAEA and NPT safeguards is something called nuclear material accountancy, which basically means the ability to verify that a state that is operating nuclear facilities is able to account for its nuclear material. Containment and surveillance is used to maintain a continuity of knowledge over a particular facility to know whether or not there has been a maintenance of seals, tags, cameras and other devices that are meant to complement full accounting of materials and to make sure there are not any overt attempts to steal materials.

Nuclear material accountancy is not the same as nuclear material accounting. Nuclear material accounting is what a state does and what a facility operator does. It is really all the bookkeeping that is associated with measuring nuclear materials, establishing material balance areas, taking inventories and the like. Nuclear material accountancy is what the IAEA does, which includes everything that the state and facility does plus some magic - some heavy dose of politics that

converts a lot of numbers into a political statement that "there is no evidence that there has been a diversion of nuclear materials in a given year in a particular state." So the difference between accounting and accountancy is this heavy dose of subjectivity, politics, magic and all sorts of things that really should not be in there - because we really need a more stringent system of international oversight of what a state actually does to verify that its own nuclear material inventories are intact.

You are probably familiar with the term Material Protection Control and Accounting (MPC&A), which is a program that the U.S. funds in Russia for upgrading the security of its nuclear materials. There is no "P" in the IAEA's MPC&A because physical protection is not something for which the IAEA has any responsibility. The physical protection of nuclear material is a state responsibility only. Under the Safeguards agreements, the IAEA does not have the authority to comment or to take action on the measures a state applies for physical protection. In other words, the IAEA has no say in the methods by which a state prevents theft by criminals or subnational groups of nuclear material from this facility.

I think this is an increasing problem, because there seems to be quite a lot of overlap between physical protection activities and the safeguards of material accounting activities that are going on in states. I think a broader view is needed. There is a Physical Protection Convention, which is a binding convention concerned with physical protection of international shipments of nuclear materials. The agreement is binding on states that are party to this convention, but it only applies to physical protection during transport or storage incidental to transport. It says nothing about domestic physical protection, the measures that individual states should take to make sure their nuclear facilities are secure. It seems that this really is an international issue because a vulnerability of nuclear material anywhere in the world is a threat everywhere in the world. People around the world are threatened by the fact that Japan, for instance, does not protect its stores of separated plutonium with armed guards, but only with unarmed guards, in the hope that there will be police response in time if someone tries to steal it. That is a threat to the whole world.

We need mandatory standards for facilities everywhere that are going to be storing or processing nuclear weapons usable materials like plutonium. To this end, there have been efforts to extend the Physical Protection Convention to domestic physical protection issues. The IAEA has designated what is called an Open-Ended Expert Working Group. "Open-Ended" is key because it means they can talk forever without coming to any conclusion. It is very convenient, but I do not know if we have the time to engage in that kind of an effort any more. Part of the interim recommendations of this Open-Ended committee is that we should extend the Physical Protection Convention to apply to domestic facilities, but there should be no mandatory international oversight of what countries do. There should be no periodic reporting requirement to an international organization of what countries do. There should be no peer reviews of an individual country's physical protection programs. And there should be no mandatory standards for any particular country's program. What exactly would that do, I don't know. Of course, the United States, which was the original sponsor of the effort to engage in this exercise, decided to endorse all these restrictions because the Department of Energy does not think any of them are appropriate for U.S. facilities. So before the game is even started, it has already been corrupted.

In the aftermath of September 11, I think it is clear that we need binding physical protection standards not only for nuclear materials, but also for nuclear facilities to protect them against sabotage, which is something else that is not covered in the existing convention, even for transport. The reason is that these dichotomies, which are encoded in the legal framework, but do not make any sense from a technical standpoint, are between state and sub-national diversion of facility, between safeguards and physical protection.<I don't understand the previous sentence> These are artificial dichotomies. A holistic approach is needed, but it is obstructed by the structure of the current treaties.

The high-minded goal of material accountancy that was endorsed by the generic INFCIRC on safeguards agreements is the detection goal: there should be a capability by the IAEA to detect a diversion of a sufficient quantity of nuclear material by an NPT member state. "Significant quantity" means roughly the amount of material it would take to build a Hiroshima type or a Nagasaki type nuclear weapon, losing about 25 percent of the stolen material in the process. These are high numbers; it is recognized that these numbers exceed greatly what a nuclear weapons state would need to make a very efficient nuclear weapon. This is a very controversial issue. Here are the numbers: 8 kilograms of plutonium, 25 kilograms of highly enriched uranium (HEU), which is uranium enriched more than 20% (U-235), or 75 kilograms of low-enriched uranium, which is derived from about 10 tons of natural uranium. These are very large quantities of natural and low-enriched uranium.

The goal is to detect a diversion by a state of these materials within what is called the conversion time, which is the time it would take a state to convert a particular nuclear material in a certain form into something that could be used in nuclear weapons. The conversion time is something on the order of 10 days with plutonium metal and 1-3 weeks with plutonium or HEU. An example of a plutonium compound that is very controversial is MOX fuel, which is a nuclear fuel that has between 5 to 25 percent plutonium in it, depending on its purpose. Spent fuel, which is fuel that comes out of the nuclear reactor, has plutonium in it, but it is dispersed in a highly radioactive matrix that presents a formidable radiation barrier. Spent fuel would be very unpleasant to steal, because of the radiation it gives off. It also requires reprocessing to convert the material dispersed in the spent fuel into separated material. The conversion time for spent fuel is on the order of 1-3 months. The working assumption here is that a state that was planning to divert material would have a hidden undeclared facility and it would not divert the material from a declared facility until the facility was operational and could essentially start up as soon as it got the material.

What is the wishful thinking here? If you will look at the standard report language from past NPT Review Conferences, whatever the status quo is seems to be perfectly fine. The Conference expressed its satisfaction with the IAEA safeguards in relation to reprocessing, storage and use of separated plutonium. So according to these endorsements, these safeguards are completely effective. There is no risk, as long as the IAEA is doing its job, that a state could actually divert nuclear materials for nuclear weapons.

But the question, of course, is how effective are the safeguards really. I am sure everyone is familiar with a lot of the problems. I will just go over some of them quickly. One of the limitations with material accountancy is that the IAEA backs away from its detection goal almost

as soon as it lays it out: it says that the detection goal is a theoretical goal, but to be realistic we need an inspection goal, which is what we can reasonably hope to achieve through inspections, given actual conditions at the facility, technical capability of safeguards measures, and the resources available to the IAEA. So, the inspection goal is what the IAEA actually tries to accomplish at facilities. It is circular reasoning because it only sets out to accomplish what it knows it can already do, through the technical capabilities of safeguards. It is a fundamental intellectual flaw at the heart of safeguards, but it does not work its way into any NPT Conference statement.

So we find that the detection goal of 1-3 weeks for plutonium compounds such as MOX becomes an inspection goal of "within one month." The committee (called SAGSI) did the original recommendations. They took the upper limit of this conversion time, added a week for good measure, and ended up with a one-month timeliness goal. This means that the IAEA should be able to detect diversion of a significant quantity of fresh HEU fuel or MOX fuel within one month. For irradiated fuel, it went from 1-3 months to within three months. In other words, the IAEA should be able to detect a diversion of enough irradiated fuel for one significant quantity of material within three months. This set the inspection schedules for facilities. For instance, a nuclear reactor that has only low enriched uranium or spent fuel has to be inspected about four times a year to meet this timeliness goal. But if a facility has fresh MOX fuel, which is not irradiated and has plutonium in it, it has to be inspected once a month.

The other IAEA magic is with the accountability verification goal, which is one of those significant quantities. For instance, detecting the diversion of 8 kilograms of plutonium. It can not be met with existing technology. In fact, the technology is only as good as the precision of the measurements and the famous formula for converting a measurement uncertainty into the actual, what's called the "expected accountancy capability." This means that if the minimum amount of material were diverted, the IAEA could actually make a finding that there was a diversion, without risking the fact that it was making an error, a statistical false alarm, and having an unnecessary conflict with one of the member states with which it has safeguard agreements. Their goal is to limit false alarms. Statistically, if there is a 5 percent false alarm probability, you end up with this inflated figure for the expected accountancy capability, which could be several hundred kilograms for a large spent fuel reprocessing plant. For instance, the reprocessing plant the Japanese are building at Rokkasho would have an output of something like 8 tons of plutonium a year. If there were a 1 percent uncertainty in the ability to measure the plutonium going into that plant (it is probably going to be higher than that), this value would be several hundred kilograms. This means that several hundred kilograms would have to disappear from the plant before the IAEA could say for sure that there was a diversion. There could be a diversion of many bombs worth of nuclear material without the IAEA able to say confidently that this is going on.

This is a practical problem in Japan, which has a very large, active nuclear program based on plutonium recycling, including a large reprocessing plant they are now constructing and the use of MOX fuel in Japan's fleet of power reactors. Although the MOX fuel program is stalled for now, it is still the Japanese plan to go forward. The Liberal Party leader in Japan this week said that if Japan desires, it has enough plutonium to use in its nuclear power plants for 3,000-4,000 nuclear weapons. This was aimed at China. The statement is true enough, but for Japan to

actually make a statement like that shows the importance of maintaining stringent safeguards against diversion at Japanese nuclear facilities.

Unfortunately, the technical limitations have resulted in the inability of the IAEA to detect large diversions in a timely manner at Japanese nuclear facilities. Perhaps the most famous case was the so-called PFPF plant, which is the Plutonium Fuel Production Facility, a plant that made MOX fuel at Tokimura in Japan. About ten years ago, the IAEA said the highly automatic MOX fabrication facility had the most advanced material accountancy system in existence. But unfortunately it did not work well and they actually built up about 70 kilograms of plutonium stuck to the ducts and gloveboxes after only six years. This corresponds to a value of the expected accountancy capability - of over four significant quantities of plutonium. This was a significant concern to the IAEA. It took them over two years to negotiate the agreement, at which point the plant was shut down, and cleaned out. They got the value down to less than 10 kilograms and that was good enough. But it cost a $100 million to resolve. They failed to meet their timeliness goal by a considerable margin for that plant. There are other examples as well, Japan has facilities where the IAEA cannot verify that there has not been a diversion, especially in large stores of scrap and other plutonium-containing waste.

I do not want to just pick on the non-nuclear weapon states, because there are issues associated with the nuclear weapons states as well. One example is the U.S.-Russian plutonium disposition agreement. This is a project that I think we are all concerned about. The US and Russia agreed in September 2000 to dispose of 34 tons of weapons-grade plutonium by either converting it to MOX fuel for use in reactors or immobilizing it. The recent cancellation of the immobilization program in the US means that MOX is the only option on the table. The goals of this program were to reduce the risk of diversion, especially in Russia, and to increase international transparency. These are noble goals. The US plans to build the MOX fabrication plant at the Savannah River Site, which is a former nuclear weapons production complex and still has military missions. The DOE intended to put this facility on the eligible facilities list for IAEA verification. This seems to be a very important part of the US-Russian agreement that both countries would open up their facilities to international verification of nuclear material.

The US is supposed to be setting an example for Russia, which has been resistant all along to that notion. But it seems things are happening the other way around. Russia seems to have convinced the US that it is not a good idea, because the US has decided to reconsider its participation in all international verification activities at DOE sites. The US under the Clinton Administration was starting to have very small pilot activities in which the IAEA would come in and verify quantities of nuclear material - plutonium and HEU - that had been taken out of nuclear weapons programs. Now these international verification activities are being put on hold, particularly in regards to the MOX plant. There is a detailed design already for the MOX plant, which should have been submitted to the IAEA if this facility was going to be on the eligible list, because design verification is a very important part of IAEA safeguards. If you are going to build a facility, you consult with the IAEA so they figure out what is the best way to apply safeguards, before the plant is built. Then you do not run into PFPF type problems. But the US is not doing that. I do not think that they are going to go forward with any IAEA activities at the Savannah River Site, and that means that the original rationale for the plutonium disposition program is almost complete kaput in my view without any form of international verification.

I only have one last pet peeve having to do with material accountancy, and that is the so-called integrated safeguards initiative. After the 1991 discovery of Iraq's violation of the NPT by having developed a clandestine nuclear program, the IAEA developed what is called the "strengthened safeguards" system. These safeguards were measures that were supposed to enhance the IAEA's capability to verify not only declared activities, but also the absence of undeclared activities, like the uranium enrichment program in Iraq. This involves additional measures and authority, which the IAEA did not have under the original safeguards agreements, including the ability to conduct environmental sampling and the ability to conduct inspections at non-nuclear sites.

These measures and others are contained in an Additional Protocol, which is in INFCIRC/540 and has not proved to be very popular - only 57 additional protocols have been approved as of June 2001. I do not know what the number is today. Only 18 have entered into force. The reason why countries do not like this is because they are accepting a lot of additional responsibilities, intrusiveness, and cost and they are not getting anything in return. So the IAEA decided it better give something in return, and came up with integrated safeguards, which the IAEA says are ways of increasing efficiency, effectiveness, safeguards, etc. What it really means is they want to relax inspection requirements at declared facilities as a gift to the countries that sign on to the additional protocol. It has been proposed that the timeliness goals for declared sites can slip a little bit for countries that accept the Additional Protocol, because the IAEA assumes that if a country tries to build an undeclared reprocessing plant now the IAEA will catch it. If strengthened safeguards were effective, the original assumption for the timeliness goals -that there would be an undeclared, fully complete reprocessing plant at the time of diversion - would be no longer applicable because the IAEA would be able to detect the plant during the construction phase. So the IAEA says that it does not have to inspect nuclear reactors and spent fuel four times a year. It can go only once a year because they will not have that reprocessing plant underground ready to go. Once they divert the fuel, it is going to take them a year to build the plant, so IAEA does not have to inspect four times a year, which is really expensive. For MOX fuel, instead of visiting every month, the IAEA can visit every three months, because if the country is going to build a facility to extract plutonium from MOX fuel, which is not actually all that big a deal, then the IAEA would be able to detect those construction activities.

So the IAEA proposed a revision for weakening the timeliness clause. I do not know exactly what that means but there are problems associated with it. The problems are that (1) the additional protocol may not be effective - there is a chance that the IAEA may miss something even with the traditional efforts, and (2) this approach ignores other risks. If a state wanted to transfer spent fuel to another country or some international group that would have a reprocessing plant in the country or that was not subject to the Additional Protocol, not even an IAEA or NPT member, the state could divert spent fuel to this other country, which has nothing to do with whether or not its has undeclared reprocessing plant within its borders. The fact that you are actually inspecting spent low-enriched uranium (LEU) fuel only once a year instead of four times a year is raising concern that this type of thing could go on. This is another reason why I think the whole international system for safeguards and physical protection of nuclear materials needs a coherent review and a holistic approach, so that proposals like integrated safeguards would not be able to get as far as they have.