Address: Global Plutonium Inventories—Planning for the Future

Leonard Spector, Assistant Deputy Administrator for Arms Control and Nonproliferation, U.S. National Nuclear Security Administration

David Albright: I would now ask for your attention for our lunch-time speaker, Leonard Spector.

"Sandy," as he is known to many, was appointed to head the Department of Energy's Office of Arms Control and Nonproliferation in September 1997. As you may be aware, under the present reorganization of the Energy Department, he has assumed the title of Assistant Deputy Administrator for Arms Control and Nonproliferation of the newly created National Nuclear Security Administration.

Prior to joining the Energy Department, Sandy led the Carnegie Endowment's Nuclear Nonproliferation Project, which he helped to establish in the mid-1980s and which grew under his leadership to become one of the premier nongovernmental projects on nonproliferation issues. It was in that context that I met him, and I greatly admired his efforts to figure out what various nuclear proliferants were doing to acquire fissile materials, nuclear weapons and their associated production technologies. In particular, I admired his ability to get that message out to the broader public and to promote discussions between governments. So it is fitting that he has gone back into government.

As you all know, Sandy is the author of countless articles, books, chapters of books, and other publications. He has served on many advisory panels to the U.S. government. Sandy, I now turn the floor over to you.

Leonard Spector: Thank you, David. It is interesting to remember the days of writing, since I don't get too many opportunities to do that these days.

I wanted to speak today about a topic that I want to call "re-understanding the back end of the nuclear fuel cycle."

As we all know, developments over the past several years, including some since February 2000, are producing radical changes in the way the international community is thinking about the back end of the nuclear fuel cycle.

I think that this new thinking can be summarized rather briefly, as follows: What we used to think of as the "open fuel cycle" is now likely to be the first fuel cycle to be closed; what we used to think of as the "closed fuel cycle" now appears to be more open-ended and uncertain than ever before. And at least one variant of the fuel cycle that was previously unimagined—the direct immobilization of plutonium—now looks like an increasing possibility for some countries. I know that you have been discussing some of these issues, and will be getting into them even further as the conference continues.

Before I defend each of these propositions, I'd like to review the current state of play within the nuclear-power-using world, so that you will understand the baseline I am using for developing my thoughts.

One trend that we see is the increased focus on the management of intact spent fuel, which is becoming an increasingly important feature of the back end. For all of us, of course, the back end begins with spent-fuel storage at reactor sites, and for most of our countries, even some that are having

spent fuel reprocessed, this is where the bulk of spent fuel is currently housed. Many of us have adopted strategies to increase storage capacity, including re-racking and the use of dry storage at reactor sites. The latter option is gaining increasing popularity here in the United States.

A number of states are also choosing to extend wet or dry storage at reactors for a period measured in decades. And some states are looking to develop centralized, intermediate-term storage facilities. In particular, I think Switzerland and Germany have been giving some attention to this.

Some states have long been committed to the once-through fuel cycle, with the expectation that spent fuel that has been in a storage mode for years or decades will ultimately be placed intact in permanent repositories. In addition to the United States, it appears that other states in this category include Argentina, Brazil, Canada, Mexico, South Africa, South Korea, and Taiwan. While not every one of these states has openly declared its preference for this option, none has opted, historically, for the most obvious alternative, namely reprocessing.

A second major category of countries includes those that have chosen to reprocess civil spent nuclear fuel—either domestically or in foreign commercial facilities—after an initial at-reactor storage phase. Reprocessing permits the separation of the plutonium and uranium content of spent fuel for reuse, while concentrating high-level radioactive waste for permanent disposition. Reuse of plutonium and/or uranium in mixed oxide fuel, of course, results in the production of spent nuclear fuel of a new kind—that is to say, spent MOX fuel—which in turn must be managed. So spent-fuel management remains a central feature of all of these fuel cycles.

Given the currently high costs of reprocessing and MOX fuel fabrication, and also the unresolved technical challenges of reprocessing spent MOX fuel, it is my understanding that no state is currently planning to reprocess this material. Thus, even those states most firmly committed to reprocessing eventually will be looking at the challenge of managing spent fuel for the long term, albeit second generation fuel.

Another category of countries also is now emerging; a growing number of states that had previously seen reprocessing as the central element in their back-end plans, either via domestic reprocessing plants or shipping their fuel abroad, are moving away from that option. Instead, these countries are favoring long-term management of intact, once-through spent fuel, with the apparent expectation that this once-through spent fuel—and in some countries along with spent MOX fuel—will someday be placed, still intact, in permanent repositories. This group of countries, which has adopted a de facto "mixed-fuel-cycle" strategy, as best I can surmise, includes Belgium, Germany, Sweden, and Switzerland.

The situation in Russia and for the operators of Soviet-designed reactors in Eastern Europe and in the NIS is even more complicated. Russia is operating the RT-1 commercial reprocessing facility in Ozersk, also known as Mayak. The facility is processing spent fuel from Russian VVER-440 reactors, from several reactors of this type built elsewhere, and from the BN-600 breeder reactor. As you know, Russia and the United States are holding discussions on halting the further accumulation of separated plutonium in our countries, which could affect these activities in the future.

The plans of several countries in Eastern Europe and the NIS that have contracts to ship their VVER-440 fuel to Ozersk for reprocessing have become somewhat cloudy. Finland has decided to manage its VVER-440 spent fuel at home. Dry storage facilities for VVER-440 spent fuel have been built or are under construction in the Czech Republic and Hungary, while long-term wet storage of this fuel is

being pursued in the Slovak Republic. It is not clear whether this is going to become the model or if the material is going to be shipped to Russia. This is still very much up in the air.

Spent fuel from Russian RBMK reactors is stored at reactor sites, and spent fuel from Russian VVER-1000s is stored at reactor sites and at a central storage facility in Zelezhnogorsk, also known as Krasnoyarsk-26, which also holds fuel from a number of VVER-1000s situated in Ukraine. The plans of foreign operators of VVER-1000 reactors that had planned to ship spent fuel to Zelezhnogorsk for reprocessing are also a bit up in the air, given the uncertainties of the RT-2 reprocessing plant at the site, whose completion has been delayed.

Russia, of course, is planning to use all reactors capable of burning MOX for the mission of disposing of 34 tonnes of excess weapons plutonium, and thus would not be able to begin burning its 30-tonne stock of civil plutonium as MOX for at least 20 years.

What will become of such currently unneeded stocks of separated civil plutonium in Russia—and I emphasize the term "currently"—and in a number of other countries? Russia has been clear that it plans to hold its separated civil plutonium stocks against possible future use in advanced reactors with enhanced proliferation resistance. Plans in Britain, Germany, Italy, the Netherlands, Spain, have yet to be formulated. My guess is that at least some of this material will be immobilized and placed in permanent repositories, but no one can be certain at this point.

Against this background, let us take a look at what is "open" and what is "closed."

First, it appears that no country is planning to implement the closed fuel cycle as originally envisioned—that is, exploiting multiple recycles of MOX or using the breeder reactor option. Instead, many countries that began down this path now face what has really become a rather open-ended fuel cycle, with the greatest uncertainties of all, including questions concerning, in some cases, how to manage separated, but currently unneeded, civil plutonium over the long term.

In contrast, champions of the open fuel cycle—principally the United States and one or two latecomers, such as Finland and Sweden—will likely be the first to close the fuel cycle, in the sense that we will be the ones to provide cradle-to-grave management of nuclear power plant fuel and all its constituent products.

Who is going to win the race is a little bit uncertain. We are hoping next year to make our selection of a site for a waste repository, and that is just the first phase of a lengthy licensing process and a lengthy operational process. So other countries with advanced fuel cycles may find themselves catching up or getting ahead of us. But I think that those of us who had this simplified vision of the fuel cycle will get home first, in the sense of cradle-to-grave management of these materials.

In this changing environment, underlying U.S. policy, at least, remains unchanged from our declarations in 1993. In particular, we will continue to stand behind commitments made to our partners in Western Europe and Japan with respect to their fuel-cycle activities. At the same time, we have adapted to new circumstances, for example, embracing the use of MOX fuel without reprocessing, in our collaboration with Russia to dispose of excess weapons plutonium.

The Department of Energy has also sought to collaborate with other nuclear power states on elements of the fuel cycle of widespread interest. In this regard, we hosted a major international confer-

ence on geologic repositories in Denver in November 1999, and we have plans for an international meeting on the technologies for plutonium immobilization, which will take place in 2001. In addition, we have launched a major new collaborative research initiative with international partners on advanced fuel cycles, known as NERI—the Nuclear Energy Research Initiative.

Let me now say a few words about the new $100 million initiative that is largely housed in the Nonproliferation and National Security part of the NNSA, the National Nuclear Security Administration.

As many of you know, we are seeking $100 million in Fiscal Year 2001 for a new set of activities with Russia, known as the "Long-Term Nuclear Nonproliferation Program." The most salient element of this new initiative is a $70 million program on Nonproliferation and the Civilian Nuclear Fuel Cycle.

The key activities that we are hoping to advance through this effort are: first, a suspension of further accumulation of separated plutonium from civil nuclear reactor spent fuel in both the United States and Russia; second, the launch of a new R&D program to examine future fuel cycles having greater proliferation resistance than the traditional PUREX reprocessing model; and third, collaborations on geologic repositories and on the issues surrounding the concept of international nuclear spent fuel storage.

Let me say a few words about each of these.

First, Minister Adamov has publicly stated on several occasions, including at the IAEA General Conference last fall, that there is no economic need for further accumulation of separated civil plutonium in Russia.

In early March, we began discussions with Minatom on cementing an agreement on this subject, and we will shortly begin technical talks on alternatives to reprocessing civil power reactor fuel, concentrating on the development of dry spent fuel storage. The new initiative, I should stress, will not in any way affect our declarations in 1993—and I am emphasizing this point quite deliberately—to stand by our pre-existing commitments to other plutonium-using countries.

This initiative is part of our larger engagement with Russia on related issues of fissile material production and security. Specifically, it extends our joint collaborations—that so far have been operating principally in the areas of weapons plutonium and excess highly enriched uranium—it extends these activities to an area where we have not done much work, and that is the area of civil plutonium stocks.

Let me now turn briefly to two other elements of our new nonproliferation initiative.

Our Russian colleagues want to see if there is a means for utilizing the energy value of the plutonium and uranium in spent fuel, but like us, they believe that separating plutonium can carry unnecessary security risks under some circumstances. Thus, they wish to investigate more proliferation-resistant fuel cycles, an approach that we share. Our new budget proposes a $20 million joint program to explore such technologies. And we are currently working on papers to define the term "proliferation-resistance" to identify potential technologies, and to create a vision of what this research might entail more specifically.

We have also indicated that we are interested in collaborative research on geologic repositories, where both the United States and Russia have already undertaken considerable work in our respective programs. We want to begin to share these experiences and work more collaboratively.

We also have stated that it would be timely for our two countries to examine the issues associated with the concept of international spent fuel storage. I want to underscore that our work in this area is very preliminary. I have just returned from Moscow, where we discussed this subject. Our agreed agenda is to identify issues that would have to be addressed if an international spent fuel storage facility were to be built in any country. So this is a very generic, very conceptual, set of discussions that we are having. We have not focused—again for emphasis, we have not focussed—on prospects for such a facility being built in Russia.

Major parts of our research and development collaborations under the $100 million initiative are contingent on Russia complying with the undertakings it has given the United States regarding nuclear transfers to Iran.

Let me just say in conclusion that for students of nuclear fuel-cycle policy, these are stimulating times, but I know that for many executives and officials who must manage the changes now confronting the industry, the task cannot be easy.

Clearly, the flux in this arena has been faster than many of us have anticipated.

Thank you.

David Albright: Thank you Sandy for that talk. We have several minutes now for questions. Yes?

Q: Thank you. I have two comments. The first concerns your remarks about Japan and France. I'd like to state that we, in Japan, do conduct multi-recycling, and have not abandoned fast breeders. That is clearly written in the bilateral agreement between Japan and the United States, and therefore is a commitment between the United States and Japan.

I also wanted to point out that, as Secretary Richardson said in an address at the IAEA, the United States does not encourage any more reprocessing worldwide, and doesn't want to see increased plutonium stockpiles. On the other hand, as you said, the United States is to honor its commitments to Japan and Western Europe. Would you elaborate more on your justification of why the United States is sticking to this commitment? Why is it differentiated from the generic concern about reprocessing?

Leonard Spector: I think that, as you know, this area has seen many discussions for years between the United States and other interested countries. We had a very strong and controversial interaction with many states at the end of the 1970s. Gradually a philosophy evolved that, with respect to the commitments that Japan and certain countries in Western Europe had made to reprocessing, the United States would find an accommodation that would allow these activities to move forward without undue interference from the United States, at least insofar as the commitments that had already been made. When the Clinton administration came to office in 1993, that decision was reiterated and extended.

On the other hand, we have a very clear policy that expresses concern about plutonium accumulation and reprocessing in certain other contexts. As you know, we have had very extended discussions with North Korea on these issues. We are very concerned about developments in Iraq. We have worked to avoid sales of reprocessing facilities to various countries. What I am trying to articulate is simply an extension of what has been our policy for many years.

In the Russian case, we have a very unique relationship. We are working on many different aspects of the fuel cycle and on issues raised by stocks of excess weapons material. You have to look at our proposed collaboration with Russia in that context. Here we are, actively trying to dispose of weapon-grade material—weapon-grade plutonium—in the program that Laura Holgate described before this group yesterday evening. In that context, scrutiny naturally turns to other parts of Russian activities. And it turns out that there is a commonality of interest: Russia is looking for a new vision for the future involving new civil fuel cycles, and we see an opportunity to collaborate with them. Along the way there is the opportunity to end the further accumulation of civil plutonium at a time when we are disposing of military plutonium by putting it back into spent fuel, in a sense "next door." So the Russian situation is unique, but I think that it can and should be harmoniously integrated in the U.S. policy.

Q: Thank you for your talk. I really thought that the statement you made was very important. I wanted to ask a frank question, and I hope that it will be taken in a friendly context.

You characterized a trend line favoring immobilization, if I understood you correctly.

Leonard Spector: I believe that you are incorrect.

Q: Well, how would you characterize the interest in immobilization?

Leonard Spector: First of all, there is a very active interest in immobilization on the defense side.

Second, we are now observing a number of states—this gets to the issue of "orphan stocks"—with substantial quantities of civil plutonium but also with no explicit plans as to how they are going to address that material. In some of these contexts, the opportunities to burn this plutonium as MOX is available and is being exploited. That is one approach. But other countries are just a bit in limbo as to how they plan to proceed. Some countries are at least likely to review the alternative of immobilization for some of their material, just as the United States is doing for its excess stocks of military plutonium.

Q: Just to follow-up: We understand the U.S.-Russian dialogue and the dual-track strategy. Last night it was pointed out that the Russians, at least grudgingly, are moving towards immobilization. But I think that when listening to your presentation, it is confusing in that it is not clear if you are presenting a "wish" or a "description" of the situation.

A second point, if I may continue. The thing that I find troubling here is the characterization that you made of a race between choices and national preferences. I know that this is not your intent. But I think that this kind of formulation tends to belie the sincerity of the U.S. commitment to work cooperatively with those nations that are continuing to ascribe some importance to the closed fuel cycle. So long as you project an image that we are really in a race, and the real agenda is to try to harass states that are reprocessing—and I don't think that this is your agenda—then you are continually in a mode of saying "we are going to honor our commitments." I'm frankly troubled by the formulation that infers an invidious comparison between national choices. But again, I'm sure that this is not your intent. Thank you.

Leonard Spector: It absolutely was not my intent. In fact, my whole approach is to attempt to characterize where we all seem to be at the moment, not a wish of where the situation ought to be.

There is an enormous amount of change, and that's why I used the term "fast flux." We are going through changes more rapidly than any of us had anticipated. The spectrum of alternatives is broader than any of us had anticipated. So for that reason, I think it is useful to review where we are and I tried to characterize the entire universe of alternatives that are now before us.

In the case of immobilization, I intended to present, very much, a descriptive situation. There is immobilization taking place, as I said, for excess military plutonium, and I think that this is a technology that is going to be available for other potential uses. Individual governments will have to decide how they want to proceed. There is considerable use of MOX. I did not say anything negative about that. But that solution will not be for every country. Some countries simply can not use that solution.

I think that it is our obligation to put additional options on the table. Secure, long-term storage is certainly an option. Immobilization will be an option. But we need to be discussing these, recognizing that no single option is going to work for all countries. That is the theme that I was trying to convey, and I hope that I have clarified it to your satisfaction.

Q: I'd like to pursue the previous questioner's line a little bit further. I am confused also about the 1993 U.S. policy, which you referred to several times. As far as I understand it, that policy says that the United States will take steps to stop the buildup of plutonium internationally, and work to draw down existing stockpiles, while honoring the existing commitments.

Please correct me if I am wrong, but as far as I understand it, the "existing commitments" are the 30-year period of prior approval, essentially, for the transfer of spent fuel to reprocessing facilities. I am not aware that there is a commitment not to say anything bad about reprocessing, or that countries won't be engaged to look at alternatives to reprocessing.

I appreciate the fact that the Energy Department is looking into other types of spent-fuel management with countries, but as the previous questioner said, it seems to me that the government has interpreted its policy as "thou shall not speak badly of reprocessing." As far as I understand the 1993 policy, the government has obligated itself to try to engage countries to stop reprocessing, or at least to bring into balance what is coming out of the reprocessing plants. I've been waiting since 1993 to see what the U.S. government is doing to engage these countries, particularly Japan, France, and Britain, to stop the course that they are on. I am not aware that anything has happened.

So I take issue with the last questioner. There is certainly no obligation not to speak negatively about reprocessing. That is certainly not what I understand the policy to be.

Leonard Spector: Let me try to be specific about this, as I try to walk a very thin line. The U.S. policy, as articulated in 1993, is that we do not encourage reprocessing, we, ourselves, do not engage in reprocessing, but we will stand by previous commitments . . .

Q: But it also says to take steps to halt and limit reprocessing …

Leonard Spector: Well, look at some of the things we have done. First, we have had a new focus, which is on the military plutonium. We certainly have taken steps to bring the stocks down—first to declare these stocks "excess," which we have done in very large quantities here in the United States.

We have worked with Russia to have material declared excess, and they have declared up to 50 tonnes of military plutonium to be excess, 34 tonnes of which will be covered by the U.S.-Russian agreement for disposition.

We have worked very assiduously with certain specific countries, as you know, to try to retard the development of fuel cycles that we are concerned about. And we have tried to be somewhat neutral with those countries with whom we have made commitments. I think that is what our policy stood for at that time.

Now, at the same time, we have an obligation to put forward alternate visions for some countries that either cannot or do not wish to pursue the original vision of reprocessing, MOX use, and so forth. I think that we are doing this in a very cautious way. One of the most successful things that we have accomplished has to do with the international plutonium management guidelines. Those have been very helpful in identifying how much civil plutonium there is in the world, and what the balance is between use and production. We have worked on these issues seriously but cautiously for the last eight years.

Q: I have a question about physical protection. Laura Holgate told us yesterday that the plutonium disposition agreement will take into account the physical protection standards that have been recommended in INFCIRC/225 rev. 4. I am curious as to whether or not there is anything in the arrangements with Russia to get Russia to support the U.S. position to amend the Physical Protection Convention to make it applicable to domestic, civil plutonium, as well as that material in international transport.

Leonard Spector: I think that we are operating at many levels with the Russian government. We are working on enhancing physical security at Russian nuclear sites through our collaborative program on material protection, control, and accounting. We are working diplomatically with Russia to explore this idea of amending the international Physical Protection Convention. And in specific agreements, we include provisions that provide for physical security on various activities that we are jointly engaged in. So I think,without specifying where we are in the international negotiations towards extending the Convention, there is a lot of work we do with Russia, and we tend to be moving in the same direction toward enhancing physical security and increasing the investment in this. We are taking this issue very seriously. This is something that is on the minds of both governments all of the time.

Q: You spoke about the moratorium on civil reprocessing at Mayak. You also spoke about the research and development for an international repository, which could be in Russia. At first glance, there is no connection between the two, but there are some other organizations—the Non-Proliferation Trust, for example—which make this connection. I was wondering if you could state what your position is on that proposal.

I also have a second question, which is related to U.S. politics. As you know, the Non-Proliferation Trust proposal could be implemented only if the United States gives permission to export U.S.-obligated spent fuel from certain countries to Russia. Under which circumstances would the United States give such permission?

Leonard Spector: I think that I have already answered your first question. We are not having discussions with Russia at this level of detail. We are only talking about the broadest conceptualization of

repositories. We have not gotten into specific proposals—we have not looked at the Non-Proliferation Trust, we have not looked at Pangea, or any of the other proposals that are out there. As I said, we have simply begun a dialogue at a very high level of generality on these topics.

We have also not gotten into the question of U.S. consent rights and how those will be exercised. To be sure, any generic study addressing the transfer of spent fuel has to take into account not only the interests of the host and customer countries, but also the interests of third countries that have consent rights or other obligations associated with that material. So, for example, peaceful-use assurances have to be guaranteed if that material had Canadian or Australian tags on it. Certain restrictions would apply to U.S.-origin material. Certain restrictions would apply to Russian or Soviet-origin material. So this is obviously a topic of interest. But our discussions have not gotten into this level of detail.

Q: Could you discuss India a little bit? India is pursuing the closed fuel cycle, reprocessing uranium 233, and looking at both fast reactor options and MOX fuel. What are U.S. efforts to get them away from reprocessing or from building a new plutonium reactor that will not be under safeguards?

Leonard Spector: U.S. diplomacy with India has been focussing on other concerns as of late. We have not really talked to them about fuel-cycle issues, per se. Our greatest concern is the possibility for further nuclear testing. We want to lock in their signing the CTBT. We want them to take part in the negotiation on a treaty banning the production of fissile material outside of safeguards, or at least a de facto ban with both India and Pakistan. Those are our first considerations. Their production of fissile material inside of safeguards is not a current priority.

Q: I'd like to comment a little bit about this immobilization process. As far as I understand it, the United States has about 4.65 tonnes of civil plutonium. I understand also that there are 6.2 tonnes of cesium 137 from fission products from activities at West Valley. That is clearly not enough—this one-to-one basis—to meet radiation self-protection standards. Even for the United States to consider the immobilization of its separated civil plutonium, there will be a challenge to get enough cesium 137.

To extend the argument further, calculated estimates indicate that for 300 tonnes of global stocks of separated civil plutonium, there needs to be continuing separations and reprocessing and also a reactor capacity of 120 gigawatts-electric—more than the current U.S. capacity—for a total of 12.5 years. That is also based on a heavy loading—six percent of plutonium in the glass log. If any of these numbers change, that will require either a higher reactor capacity or a longer time commitment to do immobilization. That is a technical challenge that, who ever is proposing the immobilization option must look into.

Of course, a specific assumption is that the immobilization will meet the U.S. National Academy of Sciences spent-fuel standard. Is that a requirement, or do the criteria need to be revisited?

Leonard Spector: Certainly for the record, the spent-fuel standard is the standard that we are trying to achieve, recognizing that there will be some potential flexibility in interpreting that standard depending on the specifics of a given situation.

As far as other materials are concerned, you have raised an important issue that we have to look into. If we are not going to be able to immobilize all of the materials to the spent-fuel standard, will there be other alternatives or options that might be useful? Again, this is a descriptive exercise. We are trying to identify what the options are for countries that have material beyond current needs, and who

do not necessarily wish to hold that material indefinitely. It may turn out that—for the group that wants to immobilize—the amount of cesium is sufficient. It may be a rather small group—maybe smaller countries with "orphan plutonium." Maybe larger countries with expectations about future fuel cycles will adopt an explicit strategy of planned storage as an affirmative part of their policy. In this case, the immobilization issue does not arise, at least in the near term. So I think that these are issues that need to be discussed further, and certainly a topic that deserves attention at the meeting we will hold on immobilization next fall.

David Albright: Are there any other questions? No? OK, we will wrap up this session. Sandy, thank you very much for your time.