Keynote Address: Russian Concept for Excess Military Plutonium Disposition

Alexander Chebeskov, Institute of Physics and Power Engineering, Obninsk, Russian Federation

Kevin O'Neill: At this time I would like to introduce our first speaker, Dr. Alexander Chebeskov.

We are very grateful for Dr. Chebeskov's appearance today. When ISIS planned this session, we invited Minister Adamov to deliver a paper on the Russian Federation's perspective on the utilization of plutonium and the future of plutonium and nuclear power in Russia. Initially, Minister Adamov responded to our invitation by sending us a very nice letter, which expressed his regrets that he could not attend, but he felt that the conference was extremely important and so he designated a speaker, the director of the Institute of Physics and Power Engineering (IPPE), Dr. Anatoly Zrodnikov, to deliver a paper on his behalf.

Unfortunately, Dr. Zrodnikov, at the last minute, had to cancel his participation. We found out about this only a couple of days ago. Given the short notice, it was not possible to inform all of you who are here today of Dr. Zrodnokov's absence. If you are disappointed by that, I am sorry. But we are very happy to have Dr. Chebeskov from the same institute with us today, who will talk on plutonium issues.

As you know, there are many high-level talks between the United States and Russia going on right now on a possible moratorium on civil reprocessing in Russia. Unfortunately, the Minister's paper was not completed, and it will not be delivered today. Instead our speaker has chosen to focus on the military plutonium side of the equation.

Of course, the two are linked. As our speaker will discuss, Russia's plans to utilize military plutonium relies heavily on use in nuclear power reactors. Given the limited number of power reactors, and Russia's lack of mixed-oxide (MOX) fuel fabrication capacity, this affects Russia's ability to utilize separated civil plutonium.

Now I would like to introduce our speaker. Dr. Alexander Chebeskov is a nuclear engineer and has been at IPPE since 1971. For the past five years, he has been the head of the IPPE Department for Nuclear Power and Plutonium Disposition. Prior to that he worked in fast-reactor physics and on other projects at the institute. He received his Ph.D. in Nuclear Engineering in 1983. He has published numerous articles on plutonium disposition, issues related to fast-reactor physics, minor actinide burning, and many other topics. I'd ask you to please give your attention to him.

Alexander Chebeskov: Good morning ladies and gentlemen. Thank you very much for announcing my presentation. I am very happy to address such an esteemed conference.

My presentation is called the "Basic Principles of the Concept of the Russian Federation on the Management of Plutonium Withdrawn During the Course of Nuclear Disarmament."

Significant quantities of weapons fissile materials—highly enriched uranium and plutonium—are being withdrawn in the course of nuclear disarmament in Russia. At the IAEA's 41st General Conference, held in October 1997 in Vienna, the Russian Federation announced the step-by-step removal from nuclear military programs of up to 500 tonnes of highly enriched uranium (HEU) and up to 50 tonnes of weapons-origin plutonium.

The scope and breadth of the nuclear disarmament process, and the continuity of its implementation, provide assurances that fissile materials withdrawn in the course of nuclear disarmament will no longer be required for military purposes.

The Ministry for Atomic Energy of the Russian Federation has developed a special document entitled the "Concept of the Russian Federation: Management of Plutonium Withdrawn in the Course of Nuclear Disarmament." The concept defines the basic principles, ways, and means for resolving this task in Russia. The realization of this tasks included in this document must be implemented within the framework of the special target program of the Russian Federation for management and disposition of the materials.

I will now discuss the Russian concept.

The first part of the concept is the problem statement. The fissile materials being withdrawn in the course of nuclear disarmament were produced in the former Soviet Union. The production of these materials required great investments in material, labor, and human resources. The materials possess significant energy potential. Therefore, the problem of managing and disposing of these fissile materials must be resolved within the framework of a national strategy for the development of nuclear power.

The problem of managing fissile materials in the energy generation aspect is a long-term one that will take several decades to resolve. This would be comparable with the time period over which the fissile materials were accumulated, and with the time needed to develop and assimilate new technologies for the next stage of nuclear power engineering.

The Russian national long-term strategy for the management of fissile materials withdrawn in the course of nuclear disarmament stipulates the efficient use of their energy potential through the development and production of closed fuel-cycle technologies; that international standards for safety and nonproliferation are observed; and that appropriate conditions for resolving the socio-economic problems of facilities and regions involved in the program are ensured.

The political aspect of the problem of management of ex-weapons fissile materials has acquired an utmost importance. This problem is a part of the overall nuclear disarmament process.

The second part of the concept concerns the principles of management of withdrawn ex-weapons plutonium.

Russia is a nuclear power and one of the founders of the Nuclear Non-Proliferation Treaty (NPT). The appearance of a new category of nuclear materials in Russia—namely, the plutonium being withdrawn from defense programs—does not lead to a degradation of international safety, nor does it demand changes in the current international regime of nonproliferation principles.

A second principle is that Russia is to determine for itself the timing of the process of cutbacks in the stock of weapons plutonium. These decisions will be based on the aims and provisions of its national defense doctrine, the level of technical development of nuclear weapons, the level of development achieved by the entire nuclear weapons complex, and also giving consideration of economic efficiency, safety, and ecological compatibility.

In Russia, the aim of managing and disposing of withdrawn ex-weapons plutonium is its use in nuclear reactors for power production. This corresponds to the long-term, strategic direction of the development of the nuclear power complex of Russia, which is oriented to the development of the closed fuel cycle. The works of this trend, underway during several decades in the former Soviet Union, now continue in Russia.

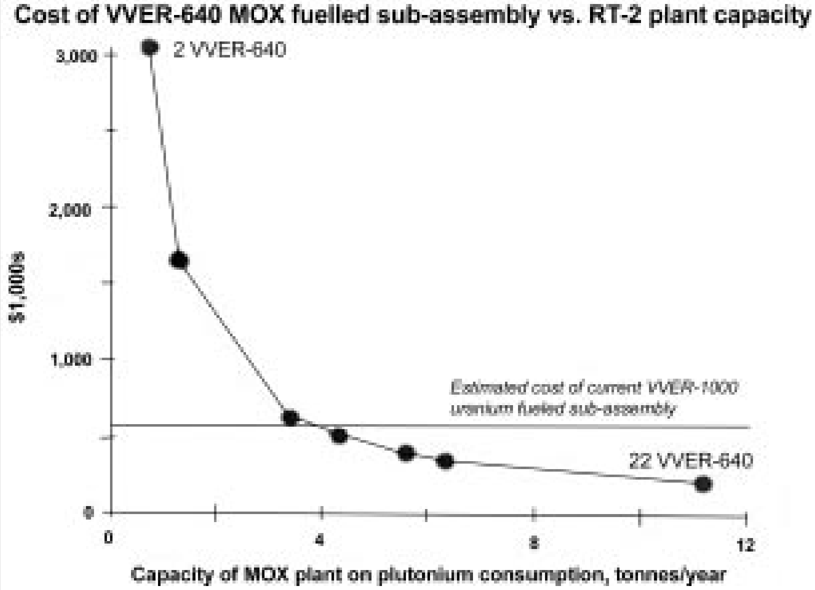
The use of withdrawn weapons plutonium is profitable: with comparatively low radiation characteristics of such plutonium, a moderate development regime can be allowed for the plutonium production facilities. The fuel and power plants developed for the operation on weapons plutonium will be subsequently redirected to the use of civil plutonium.

Russia will not implement options that do not utilize the power potential of the ex-weapons plutonium. Commercial shipment abroad of a portion of withdrawn weapons plutonium may be undertaken in the form of MOX fuel intended exclusively for non-military applications in foreign nuclear power plants.

International cooperation is the key factor in the implementation of the large-scale use of Russian ex-weapons plutonium for power production. This leads to the next topic: the problems of financing. The removal of a significant quantity of weapons plutonium from the military sphere does not mean the automatic cutback of costs in the disposition thereof. The placement of withdrawn weapons plutonium in specialized storage facilities being erected at the Mayak Production Association and the implementation of international monitoring will involve a significant increase in the costs of its storage.

The use of plutonium for power production in Russia will require additional expenses at this time, which will not be recovered for decades. Costs associated with the use of plutonium in the nuclear power industry are added costs for Minatom and for the utility "Rosenergoatom." Paying for these costs by increasing the price of electricity would be inadmissible, as this would impair the competitiveness of Russia's nuclear power industry versus fossil fuel-based power. Proceeding from economic reasons, programs of a large-scale use of withdrawn weapons plutonium for power production cannot be financed from other Russian budget sources.

Figure 1:
Cost of VVER-640 MOX fuelled sub-assembly vs. RT-2 plant capacity



As an example, I would present you with some data, indicated in figure 1. This figure shows that the price of MOX fuel production depends greatly on the capacity of the MOX fuel production plant. The X-axis, along the bottom, is the capacity of the MOX fuel production plant, and the Y-axis is the cost of MOX fuel production. The horizontal line is the existing price to produce uranium fuel. You can see that if there is very low capacity, the price is several times larger compared to uranium fuel.

Figure 2:
Cost of BN-800 MOX fuelled sub-assembly vs. Complex-300 plant capacity

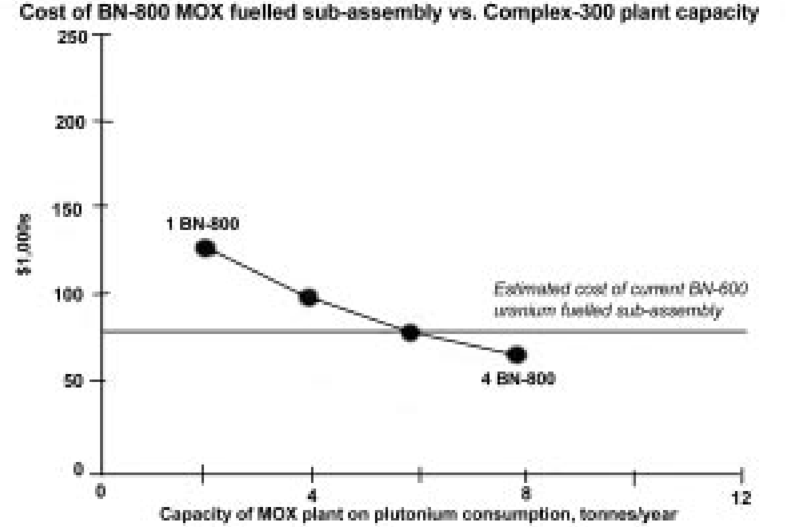


Figure 2 shows the BN-800 process. It is a comparison between the uranium price and the MOX fuel price for the BN-800 fast reactor. When the Soviet Union planned to put into operation several units of BN-800 reactors, a special MOX fuel fabrication plant, called the Complex-300, was also planned. It had a capacity up to five tonnes of plutonium per year. At that capacity, the price of MOX fuel and uranium fuel at the time being are comparable.

The next section of the concept deals with the storage of the withdrawn weapons plutonium. This is the first step in the management of ex-weapons plutonium. However, storage does not provide for the fundamental irreversibility of the process of nuclear disarmament.

Withdrawn weapons plutonium will be stored in specialized storage facilities being constructed at Mayak. It will be stored together with the withdrawn HEU. The first phase of construction of the storage facility may be completed in the year 2001. It will take another three to five years to fill this facility with materials.

Figure 3: State of Nuclear Power In Russia

Total of 29 nuclear units under operation (total installed capacity of 21.2 GWe), including:

- 13 VVER-type reactors:
  - 6 VVER-440 (Kola (4) and Novo-Voronezh (2)); and
  - 7 VVER-1000 (Balakovo (4) Kalinin (2) and Novo-Voronezh (1)).
- 11 RBMK-type reactors (Kursk (4) Leningrad (4) and Smolensk (3));
- 4 smaller units at Bilibino; and
- 3 units under construction (Rostov - VVER-1000, Kalinin - VVER-1000, and Kursk - RBMK-1000).

Nuclear power contributes to about 12% of Russia's electricity generation.
All units operate with uranium fuel.
Annual demand for natural uranium is slightly more than 4,000 tonnes.
Annual spent fuel discharge is about 800 tonnes.
Annual plutonium and minor actinide accumulation in spent fuel is assessed at 4 tonnes and 0.3 tonnes respectively.

Capital investments required on the construction of the storage facility are more than $700 million. The major portion of this sum will be covered by the United States. The projected cost of long-term storage of withdrawn weapons plutonium is approximately $2 per gram per year.

The next section of the concept concerns the use of withdrawn plutonium in the Russian nuclear power program. There are several objective conditions affecting the resolution of the problem in the timeframe scheduled. The first condition is the scope of nuclear power development in Russia. Right now there are 29 nuclear units in Russia with a total installed capacity of about 21.2 gigawatts-electric (GWe). Compared to the United States, the level of nuclear power is about five times lower in Russia. Details are included in figure 3 on the previous page.

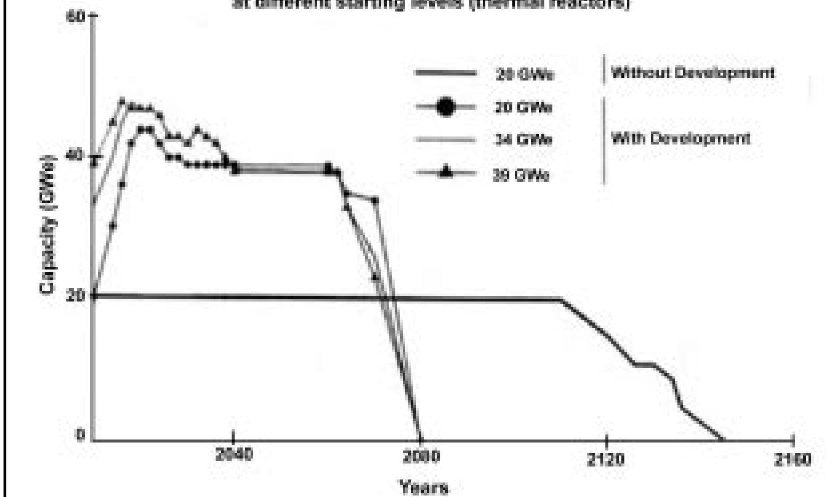


Figure 4:
The dynamics of nuclear power capacity in the open fuel cycle at different starting levels (thermal reactors)

All existing light-water nuclear reactors of the VVER-1000 type and fast neutron reactor, the BN-600, are considered to be suitable for ex-weapons plutonium utilization. The second point which can affect the utilization of ex-weapons plutonium is the availability of comparatively cheap uranium resources. Right now Russia has enough comparatively cheap uranium resources to use in its nuclear power program. As I mentioned, right now we have about 20 GWe of installed power. Under our current capacity, we can operate with uranium until 2150. If we double our nuclear power capacity, we can operate with uranium almost until the end of this century. These projections are illustrated in figure 4.

Figure 5 shows the several stages in ex-weapons plutonium consumption parameters for BOR-60, BN-600 and VVER-1000 reactors (planning activity). For your clarification, the BOR-60 is an experimental fast-neutron reactor operating in Dimitriovgrad at RIAR. At Dimitriovgrad, consumption of ex-weapons plutonium started this year and is to continue through 2014. Each year, the BOR-60 can consume up to 30 kilograms of ex-weapons plutonium.

Each power unit of VVER-1000 at the Balakovo nuclear power plant, according to our program, can start to consume weapons plutonium beginning in 2009, and will conclude in 2025. Each year, one unit can consume about 250–400 kilograms, depending on the mode of operation. The BN-600 can consume about 300 kilograms per year in so-called hybrid core (about 20 percent of MOX fuel in the core inventory, the remaining 80 percent is conventional uranium fuel) starting in 2004. This program is the so-called "early

Figure 5:
Main Temporal Stages and Ex-Weapons Plutonium Consumption Parameters of the BOR-60, BN-600 and VVER-1000 Reactors

Reactor Type	Start/End of large-scale plutonium utilization	Annual plutonium consumption per unit (kg)	Total amount of utilized plutonium (tonnes)
BOR-60	2000/2014	30	0.45
VVER-1000	2009/2025	244/407	21.40
BN-600	2004/2019	280/1,250	14.84
Total			**36.69**

start" of the BN-600 with a hybrid core. Further transition to full MOX core is planned in 2008, resulting in an annual consumption of about 1.25 tonnes of ex-weapons plutonium.

I would like to add that Russia has much experience in the use of MOX fuel in fast neutron reactors, such as the BN-600. During the Soviet past, Russia developed fast neutron reactor technology. The Soviet Union did not intend to use MOX and plutonium in thermal neutron, light-water reactors. So, as to the VVER-type reactor, Russia does not have any experience in this field. We are going to receive some experience from abroad, particularly from France, Germany, and other Western countries.

As to the potential for MOX fuel production, Russia right now only has a small scale MOX fuel production capacity to fabricate MOX fuel for fast neutron reactors. There are two lines. One line is at the Mayak site—the so-called "Paket" facility to fabricate pelletized MOX fuel. Another production line at the RIAR site can fabricate MOX fuel using another, so-called "vibro-packed," technology.

We are now planning to construct a bigger MOX fuel fabrication plant at the Krasnoyarsk site. This plant is to be based on the DEMOX project. This project is underway in accordance with a trilateral governmental agreement between Russia, France, and Germany. This project mainly is being based on the dismantled German Hanau plant.

To evaluate and make calculations, and to compare different options of ex-weapons plutonium utilization, we have chosen a model for comparison. Five production sites are going to be involved in this program. Information about these facilities is given in figure 6.

Figure 6:
Production Sites that are Involved in the ex-Weapons Plutonium Utilization Program

No.	Site Location	Functional Association of the Production Site
1	PA "Mayak," Chelyabinsk region	Storage of fissile materials withdrawn from defense programs. Demonstration and production conversion facilities. PAKET facility producing pelletized MOX fuel for hybrid core of the BN-600 reactor.
2	Krasnoyarsk Chemical and Mining Combine	Industrial facility for MOX fuel production. Long-term storage for spent MOX fuel.
3	SSC RF-RIAR Dimitriovgrad, Ulyanovsk region	Experimental fast neutron reactor BOR-60. Production line for vibro-packed MOX fuel fabrication for the BN-600 hybrid core. Production line for the first of three experimental subassemblies for the VVER-1000 reactor type.
4	Beloyarsk NPP, Zarchny, Sverdlovsk region	Power fast reactor BN-600.
5	Balakovo NPP, Balakovo, Saratov region	Four units of power light-water reactors VVER-1000.

According to different estimates, the whole program to utilize up to 50 tonnes of ex-weapons plutonium will cost $1.5–2.2 billion. But there needs to be an economic analysis undertaken, because it is necessary to determine unanimously the conditions for calculating these expenses. There are different approaches that exist in the Russian Federation and in the United States. We are now working together with American, French, German specialists to arrive at such a unanimous approach to calculate the funding needed to realize this program.

Let me turn now to the conclusions.

First, ex-weapons plutonium withdrawn from the defense programs as a result of nuclear disarmament is Russia's national asset. It has concentrated the labor of several generations of the country's citizens, and it must be used with a maximum economic and socio-political effect.

Second, when resolving the problem of management and disposition of the ex-weapons plutonium, Russia will proceed from the principle that it is inadmissible to use a method resulting in a useless disappearance of the plutonium's energy potential, such as immobilization, mixing with radioactive wastes, geologic disposal, etc. Maximum use of the ex-weapons plutonium in nuclear power is feasible.

Third, the capacities for the production of MOX fuel and the reactor inventory now available in Russia make it possible to fulfill a small-scale research program for the energy-oriented use of ex-weapons plutonium. Taking into account the development level necessary, the Russian nuclear power engineering and industry will ensure the accomplishment of the large-scale industrial program for the use of up to 50 tonnes of surplus ex-weapons plutonium in energy generation.

Fourth, the expenses for the program of using the Russian ex-weapons plutonium withdrawn in the course of nuclear disarmament in power generation appear to be much higher versus those scheduled for the respective sector of the uranium-based nuclear power industry in Russia. In light of this fact, a major condition for the implementation of the program is that Russia's added expenditures be covered by the United States and other countries interested in the fastest and guaranteed conversion of Russian weapons plutonium into forms unsuitable for use in nuclear weapons.

Fifth, international cooperation may be implemented within the framework of the government-to-government agreement being negotiated between the Russian Federation and the United States. The most important provisions of the agreement are guarantees of financial support for the program over the long-term (at least 10 years) and international (bilateral) control and monitoring of the implementation of the program under mutually acceptable conditions.

In the event that these main conditions are not met, all ex-weapons plutonium withdrawn would be stored in Russia, with an indisputable observance of requirements and terms of safety, nonproliferation, and the appropriate international monitoring and control. This solution is natural in light of the absence at this time of a shortage of uranium fuel for domestic nuclear power plants.

Sixth, simultaneously, pursuant to the Russian national strategy for the development of nuclear power complex and the practices underway for several decades, Russia will continue to develop closed fuel-cycle related technologies, where the use of plutonium is suggested. The political resolution of the issue of managing and disposing of ex-weapons plutonium must account for the ever-increasing quantity of civil plutonium generated in commercial nuclear reactors worldwide. The civil plutonium is an inherent component of the "uranium" nuclear power, and it will serve as major material for fuel production in the future nuclear power industry in Russia.

That concludes my remarks. Thank you very much for your time.

Kevin O'Neill: Thank you. Are there any questions for our speaker?

Q: Could you please return to figure 1, the graph for the cost of MOX fuel versus production rates. What is the comparable costs for uranium oxide fuel? This upper one here—the comparable costs of uranium oxide fuel is about $600,000. I guess that is the estimated costs for VVER-1000 for uranium fuel sub-assemblies?

Alexander Chebeskov: Yes, you are right. One uranium VVER sub-assembly costs now approximately $600,000 with existing prices for natural uranium and for enrichment work.

Q: What was the breakout of investment versus operations? How does the cost of the plutonium fuel become so small when you make a lot of it? You better take out the original cost and the enrichment cost of the uranium side to make a proper comparison. I think the assembly cost and the fabrication cost is comparable to that for the uranium fuel.

Alexander Chebeskov: We assume that the cost of producing the plutonium is zero when making this calculation. If you consider the price structure for uranium fuel sub-assemblies and the structure for plutonium/MOX fuel sub-assemblies, they are different. Because—for uranium fuel— we spent about one-third of the price for enrichment and about 30 percent for the natural uranium. The last percentage covers fabrication. But for MOX fuel, the situation is different. Because the cost of the plutonium is zero, almost 80–90 percent is spent on the fabrication of MOX fuel. It is natural, therefore, that if you increase the production capacity, that you will decrease the price for each sub-assembly.

Q: The numbers you gave for plutonium utilization in the commercial reactors—does that include the total MOX plutonium or just the weapon-grade portion? I understand that you will be blending down the weapon-grade plutonium with some other plutonium to bring up the isotopic level to an unclassified level such that you can tell the engineers so that they can run the plant.

Alexander Chebeskov: The table only refers to the ex-weapons plutonium in the fuel. But you are absolutely right, and I forgot to mention this. In the Russian Federation the isotopic composition of the plutonium being withdrawn from nuclear weapons is classified information. Using ex-weapons plutonium for nuclear power with international controls and monitoring will reveal this information. So Russia proposed to blend up to 10–15 percent of civilian, reactor-grade plutonium with the original weapon-grade material. The blending will be accomplished at the conversion level when metal from the weapons will be converted to oxide form. At this step up to 15 percent of civil plutonium will be added.

The figures I referred to in my talk only indicated amounts of original ex-weapons plutonium.

Q: There are a lot of rumors now about the future of Russia's program. I understand, for example, that the program to shut down Russia's plutonium production reactors will be reoriented, at least according to recent speeches by Russian officials.

Alexander Chebeskov: I'm sorry, but I haven't heard about these rumors and am unable to answer your question.

Q: My question concerns the use of VVER-1000 reactors to 2025. Getting into the civil plutonium side, are you confirming that the plutonium that would be coming from RT-1 until 2025 is going to be stockpiled, and that there are no reactors in which to use that material? I think Russia has already separated about 30 tonnes of civil plutonium. Now you said that there would be some blend-down with reactor grade material. But what about the rest?

Alexander Chebeskov: The situation regarding the operation of Russian reprocessing plants is the following: we now have about 30 tonnes of separated civil plutonium due to the reprocessing of VVER-440 fuel at the RT-1 plant, as you said. There are some ideas about how to modernize this plant so that it can reprocess VVER-1000 spent fuel once the VVER-440 fuel is exhausted. The design lifetime of RT-1 ends in 2006, but if Minatom modernizes this plant we can separate much more plutonium. Another option being considered is the probability of putting into operation the RT-2 plant at Krasnoyarsk in 2015, according to plans drawn up during the Soviet time. These projections are summarized in figure 7.

Figure 7: Options of Civil Plutonium Accumulation

Possible Option	Amount of Civil Plutonium Accumulated by Year, in tonnes			
	2000	2010	2020	2030
1. Existing RT-1 Plant operates until the exhaustion of VVER-440 spent fuel stocks.	>=30	41.6	45.6	45.6
2. Having reprocessed the VVER-440 spent fuel, RT-1 then proceeds to reprocess the VVER-1000 spent fuel at a capacity of 300 tonnes / year.	>=30	41.6	55.2	74.4
3. RT-1 Plant finishes its operation (as in option 1), then in 2015 the RT-2 plant is commissioned with the capacity to reprocess 1,000 tonnes of spent fuel per year.	>=30	41.6	81.4	147.5

I would like to point out that we invented these produced plutonium accumulation scenarios for use in some scientific studies, exercises, and projections to try to predict the situation in the future. Due to many existing uncertainties, these scenarios may not coincide with the official Minatom position on this issue. So, I would ask you to please treat these scenarios as speculative, scientific exercises, and not as foregone conclusions.

David Albright: I'm sorry to interject, but you misunderstood the question. He was asking what Russia is going to do with the 30 tonnes of civil plutonium as declared as separated in RT-1? What will happen to that plutonium?

Alexander Chebeskov: I guess that the Russian position is the following: We first should utilize the ex-weapons plutonium being withdrawn from military programs. Afterwards, we can use the same facilities to utilize civilian, reactor-grade plutonium. But right now, using civilian plutonium before military plutonium is not admissible. This is my personal point of view, though.

Q: Could you please tell me the loading of plutonium—what percent—in MOX fuel you are planning on using?

Alexander Chebeskov: For the VVER-1000 reactors, we are going to use a one-third core loading with MOX fuel. Each MOX sub-assembly will contain three levels of enrichment of plutonium. Approximately 4 - 6 - 8 percent of plutonium to be loaded into MOX fuel. For the BN-600, the ratio of plutonium in MOX fuel is about 25 percent.

Q: It seems to me that the bottom line of your talk is that MOX is more expensive than fossil fuel, Russia can't afford MOX, and if the United States or others don't pay, then Russia will simply store the weapon-grade plutonium. Does that mean that Russia will not consider storing or disposing of immobilized plutonium?

Alexander Chebeskov: We need some additional money to use MOX fuel with ex-weapons plutonium. But as I mentioned before, we also need money for long-term storage. If we withdraw from defense programs 50 tonnes of weapons plutonium and the storage costs are $2 per gram per year, we need to spend $100 million per year simply for storage. It is necessary to calculate the various options regarding the cost effectiveness of using this plutonium.

Q: You referred in passing to bringing parts of the Hanau MOX plant from Germany to Krasnoyarsk. It is my understanding that the German Foreign Ministry has stated in the press that it opposes any such plan. So I wonder if Russia—when making its plans—is dismissing the opinion of the German government, or if Russia is waiting until the German government changes hands. What is your thinking there?

Alexander Chebeskov: I am not a politician. I am only a technical expert. But we have considered the possibility of using part of the equipment, or maybe all of the equipment, which would be transported from the Hanau plant to Krasnoyarsk. I do not know about the political aspects of this program.

Q: If I understood it, you estimated the cost of the disposition program to be between $1.5–2.2 billion. It is my understanding that pricing this program has been one of the big issues, in that we are in the end-stage in this country and in Europe in pricing out this cost. How comfortable are you with those estimates?

Alexander Chebeskov: As I mentioned, we are working to develop a unanimous methodology for economic analysis. Of course, there are big differences between $1.5 billion and $2.2 billion. And we are working also to decrease the uncertainties in our economic calculations to the maximum possible extent. But, please understand that the whole program is too big, too complicated, too long-term, and sometimes we don't have appropriate information on costs and have to use only experts' assessments. According to information from our U.S. colleagues, they need about $3 billion to utilize the same quantity of ex-weapons plutonium in the United States.

Q: Could you comment on the state of increasing the security of fissile materials storage in Russia?

Alexander Chebeskov: As you know, in the former Soviet Union the key to security was Russian soldiers with Kalishnikov rifles. In the former Soviet Union, this was rather efficient. But now we have a democracy. Now, we have a lot of contacts with the United States and the European Union, and technical measures are being installed at all of Russia's nuclear facilities to ensure the physical protection of nuclear materials. I think that, by working together with our foreign colleagues, we will achieve good protection of these materials.

Q: If I am to understand, at what date do you plan to start using the plutonium either in the BN-600 and the VVERs. Is it still 2007?

Alexander Chebeskov: We are discussing with U.S. specialists to simultaneously begin utilizing ex-weapons plutonium in both Russia and the United States. According to this plan, we should start to load MOX fuel into reactors in 2008. We should commission MOX fuel production no later than 2007. But Russia wants to have an early start with the BN-600 in order to present the fast reactor option to the international community as the best option. We are going to start with the BN-600 reactor in

2004 with a partial loading of the core of about 20 percent of MOX fuel. The other 80 percent will be highly enriched uranium fuel.

Q: In your presentation, you talked about the possibility of shipping abroad a portion of your weapons plutonium in the form of fuel. Could you elaborate on that comment? Who would receive that plutonium? A second question—can you provide any insights to the negotiations between the United States and Russia to defer the reprocessing of light-water reactor fuel at RT-1?

Alexander Chebeskov: As to the first question, I think that there is a possibility for Russia to sell some MOX fuel fabricated with ex-weapons plutonium to other countries. This is indicated only in principle: I don't know if there have been any negotiations between Russia and any other interested party.

I really don't know the answer to your second question. But RT-1 reprocesses spent fuel mostly from VVER-440 reactors. We have several units of these reactors, and have also constructed several such reactors abroad. We use reprocessed uranium from VVER-440 spent fuel in RBMK reactors and I do not think that we have enough appropriate storage facilities for such spent fuel, and so this fuel needs to be reprocessed. However, I am unaware of the political aspects of the question you raised.

Kevin O'Neill: Our time is growing short. I think we will take only one more question.

Q: You mentioned highly enriched uranium. My understanding of the U.S. nuclear arsenal is that it contains about five times as much bomb-grade uranium as it does plutonium. Could you discuss plans for using ex-bomb-grade uranium from Russian weapons?

Alexander Chebeskov: There is an agreement between Russia and the United States to sell to the United States up to 500 tonnes of highly enriched uranium to be used in U.S. nuclear power plants. I think the same situation can be used in Russia in the future when we have a shortage of natural uranium.

Kevin O'Neill: Thank you very much for your insightful talk.