Plutonium Utilization (I)

Jean Claude Guais, Cogema, Inc.
Masayuki Iwanaga, Japanese Nuclear Cycle Development Institute, Tokai-mura, Japan
Kinji Koyama, Japanese Institute of International Affairs, Tokyo, Japan

Kevin O'Neill: Good afternoon. I would like to introduce the speakers on our next panel, which covers national strategies for plutonium utilization.

The first speaker is Mr. Jean Claude Guais, who will discuss the French perspective on plutonium utilization. Mr. Guais is the Vice President of Strategic Development of Cogema, Inc. based in Bethesda, Maryland. He has more than 35 years experience in nuclear energy and the nuclear fuel-cycle fields, encompassing both the domestic French nuclear program and the international scene.

Afterwards, we will hear from two Japanese representatives, who will present Japan's views with respect to plutonium utilization.

The first Japanese representative will be Mr. Masayuki Iwanaga, who has served as the Director of the International Cooperation and Nuclear Material Control Division of the Japan Nuclear Cycle Institute since 1998. Previously he has held many other positions in JNC and its predecessor agency, dating back to 1985.

The final person to speak will be Mr. Kinji Koyama, who is presently a senior research fellow at the Center for the Promotion of Disarmament and Nonproliferation at the Japanese Institute of International Affairs, a position that he's held since 1997. Prior to that he spent more than a decade as the principal scientist of the safeguards technical laboratory at JAERI. He has also spent several years as a group leader for safeguard data evaluation at the IAEA during the early 1980s. He is a consultant at the Japanese Science and Technology Agency, and also a member of SAGSI, the Standing Advisory Group for Safeguards Implementation.

Jean Claude Guais: Good afternoon. Thank you Kevin for the introduction. I will be the first industry representative today, and I hope I will not be the first suspect. It is indeed an honor and a pleasure to be in front of you. I will try to give you a somewhat practical, real-life kind of presentation on the plutonium industry, based on my experience with my company for many years.

I will not do too much arithmetic, as we have already seen various numbers, including the fascinating variations presented by David Albright.

I would like to make the case for recycling plutonium—that is no surprise coming from me. I will discuss the value of reprocessing, conditioning and recycling—or "RCR" as we term it—on a strategic, economic, and environmental basis. Then I will spend a little time on proliferation resistance as a major specific criteria, on plutonium tracking—as it is the main topic of this conference today—and finally some conclusions and personal remarks.

First, the value of reprocessing, conditioning and recycling. I would say a few words on each of the following: strategy—including energy resource management and fueling the nuclear powered future—safety, the environment, the economy, other benefits, and side effects.

Let me start with strategy.

Although some of you may already be familiar with this calculation, it is useful to remember that the energy content of one gram of plutonium is equivalent to between 1–2 tonnes of oil equivalent, depending on the number of recycles—I'm speaking of MOX recycling, not fast breeder reactors. This means that a tonne of spent fuel is equal to 20 thousand tonnes of oil equivalent, and the present U.S. inventory of spent fuel would represent something like 1–2 billion tonnes of oil equivalent, or 3 billion tonnes of coal. So that's obviously a huge energy deposit.

The second point regarding the strategic value of RCR is what I call "fueling" the nuclear power future. We believe that maintaining a high level of operational experience in actinide chemical engineering, automated technologies and industrial organization for site conditions is necessary for making the capacity for the development of nuclear power in the future, in particular regarding more advanced production systems. France is fortunate to have a heavy involvement at the teaching level; we have students still learning things about nuclear generation. We still have R&D activities. Also—and this is very important—we have operational experience in the plutonium industry and in related industries. All of that is necessary, in our view, to make possible the development of more advance production systems in the future.

I will say also a few words about safety. I believe that, basically, people know that we are serious about safety, both on reprocessing and MOX production and use. There is no real challenge about safety of the operations themselves.

We could address and discuss the question of MOX use in reactors. French and German operators are now happy with MOX performance, both in baseload and load-following modes of operation for their reactors. The behavior of the MOX rods is in excellent accordance with the simulation computing models. According to EDF, the French utility, MOX equals or behaves even better than uranium oxide fuel. Globally, they say that MOX fuel operational safety is as satisfactory as uranium.

Regarding transport: I think the safety of land, road and rail, and sea transport of fresh and spent MOX fuel has been demonstrated, at least in France and in Europe and in one case, with fresh MOX fuel, the first shipment of Europe to Japan last summer.

The safety of final disposal: Basically, avoiding the disposal of plutonium in the ground can only improve disposal safety. As you remember, plutonium contributes to more than 80 percent of potential residue of toxicity of the spent fuel after a few hundred years, and remains so for up to 100,000 years.

Regarding the environment and waste management: We believe that sorting out the components of spent fuel, conditioning the waste in proper conditions and recycling valuable materials, can only make sense in terms of the proper attitude *vis-à-vis* the environment. The purpose of reprocessing is to separate the constituents of spent fuel into recyclable materials on the one hand, and final waste in a form suitable for safe, long-term storage. This matter of reprocessing, as a prerequisite to safe, long-term disposal, is an angle that should not be neglected.

In terms of the effects of our reprocessing facility at La Hague on its environment, I would note that the current level of radioactivity release is 0.06 mSv per year, which is far below the 1 mSv Euratom rules, and heading to 0.03 mSv per year, which is qualified by ICRP as "a level of trivial risk."

The La Hague plant is presently under a public inquiry process for a license renewal. This is an opportunity for dialogue with the public and update of the information.

Next, I will address the matter of economy. First, when you compare the direct costs per kilowatt hour of the two options for the back end of the fuel cycle—that is reprocessing or recycling versus direct disposal—you do not find a large difference between the costs. The difference is only 10 percent according to the OECD/NEA. But you do find a large difference between the uncertainties of these costs. Reprocessing and recycling is a well-established industrial and commercial activity, while direct disposal is still only known as a paper project and cost estimation.

Then there is the matter of considering the "externalities." In terms of saving natural resources, waste disposal, reduction of volume, heat power and radiotoxicity of the waste to be disposed of, and global strategy—which I mentioned earlier—there are a number of externalities that you have to consider in addition to the direct costs, and that works in favor of RCR.

And I may mention an interesting study, which has been made by Professor Cady of Cornell University who addresses two important points—the point of externalities and point of discounting costs.

The other benefits of RCR: I call these side effects. They include application of some processes and technologies to weapons-plutonium disposition, both in the United States and hopefully in Russia. There is relevance for both solutions—in the MOXification of plutonium and for immobilization. Both these technologies have been developed, licensed, and industrially applied in the course of the civilian fuel cycle. Also, another benefit and side effect is the transfer of technologies and experience to decommissioning and decontamination of nuclear facilities, reactors, laboratories, and weapons production facilities, and also for the cleanup of defense-related sites.

Now, "*a chacun sa verite*"—that roughly translates in American to: "To each his own." What I'm trying to say here is that global strategy values, energy dependence, engagement in sustainable development—basically at the government level—and also electricity production competition at the utilities level, and the cost structure in the industry—all of these macro-parameters, if you will, vary with places and time. I made once, around 12 years ago, a presentation at the Uranium Institute, and the subtitle was "From Cornucopia to Scarce Land." I showed that geopolitical conditions lead to different conclusions in the choice for the back-end of the fuel cycle. I'm just trying to repeat that point.

In fact, I believe that to a large extent, the policy of recycling nuclear fuel is a very strong indicator of a country's general strategy of pursuing a nuclear power program. In simple mathematical terms, recycling is the derivative of the nuclear power evolution as a function of time. A positive attitude for recycling is a sure indicator of the willingness to develop a nuclear power program. Conversely, if and when a country decides for a nuclear power phase out, then it is highly probable—but not absolute—that this country will forgo reprocessing and recycling. The example is Sweden, of course. Antinuclear activists know that very well when they attack the "plutonium economy."

Next, I would turn quickly to the proliferation issue. The first point is to address what we mean about proliferation. We all know that the debate, which is very difficult, is also very ambiguous, because we all have various meanings behind the words. Do we mean proliferation by weapons states; by advanced non-weapon states; by smaller non-advanced states; by so-called "rogue states"; or by terrorists? The value of the civilian plutonium in front of the various risks and dangers are very different.

What are the pathways to proliferation? Well, here again, all of you here know well that there are various pathways to proliferation. I mention here the question of fissile material availability—including "loose nukes," HEU, plutonium from research reactors, commercial plutonium from CANDU reactors, and commercial plutonium from light-water reactors.

In one view the nonproliferation community is really concentrating on that line. We believe that the fair approach is to look at all the various pathways beyond the material itself. You also have the production pathways, through various enrichment technologies—which is, of course, a very serious question that we don't maybe see enough—and also production reactors. A proliferator also needs the mastering of all the components and know how to build the bomb.

What is the proliferation resistance of RCR? The overall result of the RCR strategy is three things: consuming plutonium, having the remaining plutonium under the spent-fuel standard, and degrading the remaining plutonium. So these objectives of RCR look like a reasonable answer to the worries about plutonium proliferation.

Now, during the course of these operations, you need to have serious barriers to proliferation. I have defined them in three classical categories.

First, the material quality itself and its attractiveness—I don't know if we should open here again the question of the isotopic attractiveness of commercial plutonium against weapon-grade plutonium. At least, we would probably agree that commercial material is really less desirable than weapon-grade plutonium. We can come back to that.

The second category is technical barriers, which refers to the attractiveness of facilities and conditions during transport.

The third barrier to proliferation are institutional arrangements.

So—depending on your personal attitude—you may be more interested in trying to enhance the technical barriers or material quality barriers, or rely on the institutional arrangements. In fact, it's a mix of all that.

I also would like to draw an analogy with other industries, which is illustrative. In the process of the overall RCR strategy—separating plutonium is not an end, *per se*. The objective, as I mentioned earlier, is to produce electricity. So, the analogy may or may not please you, but if you look at the pharmaceutical or biochemical industry—in the process of preparing vaccines, drugs, or other end products—companies are isolating and purifying very dangerous materials, such as toxic chemicals or microbes. That is a part of the process, but we benefit from the outcome. No one is asking those industries to close because, at one point in their processes, they are isolating or separating dangerous materials that could be diverted to make weapons. All we are asking from them—properly—is to take safety seriously, and to implement all of the safety and protection measures that are required to the process of isolating these dangerous materials. The plutonium industry is just asking for the same treatment.

Comparing the closed fuel cycle and the open fuel cycle: What is the final state of the plutonium? In case of RCR, there is plutonium consumption; in the case of the open fuel cycle, there is no plutonium consumption. The same holds true for plutonium degradation: There is degradation in the closed fuel cycle, but not in the open fuel cycle. Regarding the spent-fuel standard, both fuel cycles are satisfactory. And, on top of that, in the case of reprocessing and recycling, you have electricity production, which you do not in the open fuel cycle.

Next: plutonium tracking. I would briefly like to give you a few numbers for you to consider, and we can come back to them during the discussion. These figures are for those of you who don't know; a fabrication capacity of 300 tonnes per year of MOX fuel—and we will see if this is a reasonable figure to consider—means that 7.5 tonnes of plutonium are annually destroyed. And the 14 tonnes of plutonium remaining in the spent MOX fuel, once in the spent fuel, is isotopically degraded.

The plutonium consumption to date in France is around 40 tonnes. As an order of magnitude, the quantity is comparable to the U.S. weapon-grade plutonium excess inventory.

Also regarding plutonium tracking: The equilibrium between reprocessing capacity and the MOX recycle capacity depends on the MOX burnup, as David Albright mentioned already. The ratio is something like between 1:7 and 1:10, meaning that you have to reprocess seven to 10 spent fuel assemblies to fabricate one MOX fuel assembly. One thing to remember here, also in terms of plutonium tracking, is that one light-water reactor loaded with 30 percent MOX fuel is a zero net producer of plutonium.

So where is the plutonium? Very simply said, I believe the best place for plutonium is in the core of the reactor. When it is unloaded as spent fuel, you should return it as MOX. When you separate it—remember what I said about the pharmaceutical and biochemical industries—when you separate it, you have to implement safety, safeguards, and physical protection measures, of course.

Now, let's move to conclusions.

If I may try and walk in the other's shoes, like from the defendants to the plaintiffs, I ask you to please look for the right suspects. What I mean is that there is not just separated commercial plutonium as a suspect. There are also loose nukes, HEU, enrichment technology, and even spent fuel.

So, please consider plutonium as another critical intermediate product, and not only as the "most deadly, man-made substance." Plutonium is, indeed, a natural substance. You may know that your mother-in-law's flower pot, on her windowsill, contains several million atoms of natural plutonium.

I mentioned the improvements for the future, including advanced systems. I already mentioned that there is no single right answer, and no one single ruler, so let us respect the various, honest attitudes, and share and enrich from the difference in point of view.

We in the industry believe that we are active members of the nonproliferation community. We help destroy and degrade plutonium while producing energy out of it. We welcome safeguards, we implement physical protection, we participate in weapons plutonium disposition programs, we know that our very existence as an industry depends on strict nonproliferation. So please consider us as members of the nonproliferation community.

To conclude, we in the industry believe that we are an actor of the nonproliferation effort.

Thank you very much.

Masayuki Iwanaga: Thank you for giving me the opportunity to give a presentation on the Japanese nuclear science program.

Needless to say, the basic policy of Japan is to use nuclear power for peaceful uses, and nothing else.

My presentation is to cover overall issues, including the policy of the Japanese government and also some recent aspects of nuclear materials, especially the plutonium utilization program in Japan. After my presentation Mr. Koyama will give a presentation elaborating on safeguards and notification features.

The principle that Japan uses nuclear energy for peace and nothing else is the basis for Japanese nuclear fuel-cycle policy. Since the establishment of the Atomic Energy Fundamental Act, Japan has promoted the development of nuclear energy strictly for purposes limited to peaceful use, consistently retaining the principles of democracy, independence, and disclosure. Supported by the earnest wish of its people for the total elimination of nuclear weapons, Japan has joined the NPT, accepted the strict safeguards stipulated by the IAEA, and is implementing appropriate protection for nuclear materials in order to promote peaceful use of nuclear energy.

Recently, there has been debate overseas voicing the suspicion that Japan could be intending to develop nuclear weapons. Such a suspicion is extremely harmful to the Japanese people, who are the only atomic-bomb victims in the world and who, as a result of this experience, wish any and all nuclear weapons to be completely eliminated from the earth. This kind of argument can also be a major obstacle to technological development for the peaceful utilization of nuclear energy. However, while aware that such misgivings are possible of some countries in the world, and wishing to make efforts to dispel such misunderstandings, we will continue to devote ourselves to the development of the peaceful use of nuclear energy.

Well, starting with these principles, there are several major issues to be considered. The first is because of Japan's devotion to the peaceful use of nuclear energy. I will discuss several reasons.

First, as is well known, Japan is highly dependent on foreign countries for energy. Japan is clearly lacking in energy resources. For instance, Japan's primary sources of energy that were imported were nearly 80 percent in 1996. For imported petroleum in 1996, the figure is almost 100 percent, and petroleum imported from the Middle East was 85.2 percent in 1999, so there is a high dependence on Middle Eastern petroleum. Food imported from foreign countries was 60 percent in 1999.

These indices shows how Japan is dependent on foreign countries. So in this situation, Japan is aware that to guarantee its own peace and continued survival in the world community, it is important to take the initiative in realizing international policies and growing stability. Japan chooses to benefit through politics, through participating in international cooperation and conditions of free trade all over the world. We emphasize that the development of nuclear weapons, in Asian countries in particular, results in nothing but international tension and confrontation, loss of comprehensive security, isolation from the international community, and the consequent collapse of domestic economics.

Second, the only way in which Japan will be able to secure its existence in the 21st century is to seek open-ended public interest. That is, when Japan utilizes nuclear energy for peaceful purposes, this should contribute to the public interest of the world as well as for Japan. For the security of Japan, there is no point in using nuclear energy for anything other than peaceful purposes. Rather, the "public interest" of Japan will be realized with a calm and orderly international community.

Third, there is the experience of the atomic bomb. It is needless to say that the Japanese people had atomic bombs dropped on them in Hiroshima and Nagasaki in 1945. A Japanese fishing boat, the *Dai-Go Fukuryumaru*, was exposed to radiation during a U.S. hydrogen bomb test in 1954. These experiences of the cruelty of nuclear weapons, which are rooted in the Japanese mentality, have brought about hatred for any state policy that would cause Japan to become a potential assailant of other people. The academics in Japan also detested such technology to such an extent that there were no scientists or engineers who would approach atomic bomb development in Japan.

Fourth, nuclear armament never pays. The U.S. government places a priority on keeping Japan away from nuclear armament. Therefore, nuclear armament for Japan will immediately affect relations with the United States, which is most important to Japan. If armed with nuclear weapons despite the NPT, Japan will repel the international community, reduce its political influence and consequently lose any opportunity to become a permanent member of the U.N. Security Council, which is Japan's diplomatic goal.

Next, I would like to discuss issues related to security and transparency through the international nuclear management system.

Overall, Japanese nuclear-energy activities are extremely transparent, and are supported by the various international nuclear management systems, as follows. First, to fulfill the responsibility as an NPT signatory, Japan has also signed the comprehensive safeguards agreements with the IAEA, accepting the safeguards covering all the nuclear material existing within the country. Today, it is estimated that 20–30 percent of all IAEA inspections are carried out in Japan, though no suspicion of nuclear material diversion has been indicated. The IAEA sequence has been functioning effectively in Japan, and it is clear that no nuclear materials for peaceful purposes have been diverted for military use.

Second, an Additional Protocol to refine the detection of undeclared nuclear materials and nuclear development activities was agreed to at the IAEA Board of Governors meeting in May 1997. This is codified as INFCIRC/540. Japan had played an active role in developing the draft of the Additional Protocol. According to the Additional Protocol, we performed trials of expanded declaration and supplementary access, and Japan was as early as the eighth country to ratify the Additional Protocol. The original intention of the Additional Protocol was a containment towards the countries where undeclared nuclear materials are likely to be used for military purposes. However, Japan was the first to ratify it among the countries with larger scale nuclear related activities, as we believed that a country which devotes itself to the peaceful use of nuclear energy should be a good example to the world. After the ratification, the domestic safeguards system was reviewed and improved to an adequate level.

Third, our constitution defines the sincere implementation of international agreements as one of our national policies. More than 70 percent of our nuclear materials, including 73 percent of Japan's enriched uranium and 75 percent of its plutonium are subject to "The Agreement for Cooperation between Japan and the United States Concerning Peaceful Use of Nuclear Energy." Thorough details of the materials management are provided by the United States, which observes information of our main activities. Furthermore, most of the materials stored in Japan are also under observation by nuclear fuel supplying countries such as the UK, France, Canada and Australia, individual agreements with which have been signed.

Next, I would like to discuss Japan's initiatives in the peaceful use of nuclear energy. Japan contributed to developing the "Guidelines for the Management of Plutonium," which was discussed in a previous session. Japan played a very active role in developing the guidelines, which was jointly prepared by Japan, the United States, Russia, the UK, France, and others. Our active involvement in the guidelines is evidence that we have no other intention than the civil use of plutonium.

Second, progression to the loose international program for the disposition of Russian plutonium derived from the dismantled nuclear weapons, Japan will make efforts to further improve its nuclear technology and the skill of its engineers, and contribute with technology for the peaceful use of nuclear energy to retain and enhance the nonproliferation system. In this progression, we made a choice to assist with the BN-600 approach, as already mentioned by Dr. Chebeskov earlier today.

The U.S. Senate's refusal of the Comprehensive Nuclear Test Ban Treaty (CTBT) ratification has a critical influence over other non-signatory countries, particularly those countries whose signing is essential for the enforcement of CTBT. Japan is going to implement diplomatic efforts towards early enforcement of CTBT.

Also, Japan plans to hold a world symposium where we can clarify our standpoint that we have no other intention that for the peaceful use of nuclear energy.

In addition to those initiatives, we can have some other abilities to enhance the nonproliferation regime. We will propose international cooperation for developing technologies of proliferation-resistant reactors and fuel-cycle facilities. We intend to conduct a feasibility study into introducing a civilian organization for the systematic research and development of principles and systems for peaceful uses of nuclear energy, as well as the nonproliferation of nuclear weapons.

I will turn now to the plutonium utilization policy of Japan with devotion to the peaceful use of nuclear energy.

First, I would note the international contribution of a country which has few natural resources but plenty of technology for the peaceful use of nuclear energy. Japan has exerted itself, since 1956, towards securing an energy supply. However, our country still depends on imports for most of its energy resource needs, as I mentioned. Its energy consumption per capita is just behind the United States.

Energy resources could be exhausted in the 21st century, and all nations should participate in a continuous, worldwide collaboration towards finding a solution to this problem, which is critical to all people living on earth. Japan in particular, which is a giant consumer of energy resources, should endeavor to establish its plutonium utilization technology that enables efficient use of uranium and thus contributes to energy security for the world.

One must also consider issues of cooperative security; that is, Japan's nuclear activities under new international circumstances. The world has been led to a structure of interdependence instead of antagonism since the end of the Cold War. However, the deterioration of the global environment, the spread of poverty, and an increase in regional disputes indicate the necessity for more serious cooperative security. Therefore, it will be essential for Japan to make positive contributions to the worldwide agenda.

Regarding the plutonium utilization policy of Japan, we have strictly limited our nuclear development and utilization to peaceful purposes under the Atomic Energy Fundamental Act. Our country thoroughly believes in the three non-nuclear principles with stipulate "no possession, no manufacturing, and no right of entry" concerning any nuclear weapon. In promoting the nuclear fuel cycle, we are strictly controlling nuclear materials stored in Japan, and as a rule, not preserving any surplus plutonium which has no purposes of use.

Currently in Japan, plutonium utilization programs by LWRs and fast breeder reactors are in progress. Along with this, intermediate storage of spent fuel is being prepared for practical use to make up the deficiency in capacity of reprocessing facilities.

In particular regarding plutonium utilization programs for LWRs, we believe that this enables an efficient use of uranium resources and is the most dependable form of plutonium utilization now existing. Plutonium use in LWRs has been planned and developed in the expectation that it would remain as the core measure in Japan for the coming decades.

The original program was to start at Generator #3 (BWR) at the Fukushima No. 1 Nuclear Power Plant of the Tokyo Electric Power Company, and at Generator #4 (PWR) at the Takahama Nuclear Power Plant of the Kansai Electric Power Company in 1999, as well as at Generator #3 (BWR) at the Kashiwazaki Kariba Nuclear Power Plant of Tokyo Electric Power Company. However, due to the case of corruption concerning fuel-production data in the UK, MOX fuel has not been supplied to the plants yet. As preventative measures against such illegal acts are to be taken, endeavors are being made to ensure implementation of the program, and an overall total of 16 to 18 generators, including the Ohma Nuclear Power Plant (ABWR) with the MOX core, will be coming on line by 2010.

As regarding plutonium utilization programs by fast breeder reactors, while it is true that the thermal utilization by LWRs is an intermediate form of plutonium utilization, utilization by fast breeder reactor is the final form of plutonium utilization. This enables the ultimate efficient combustion of plutonium fuel. Feasibility as a power generating plant has been studied at "Monju," the prototype reactor built for this purpose. However, it has not been in operation since 1995, when an accident occurred where sodium leaked from the secondary coolant system.

Regarding Japan's intermediate storage program of spent fuel from plutonium utilization: In Japan, an excess of spent fuel over the domestic reprocessing capacity is to be stored properly as a part of the energy resource stock until it is reprocessed. For this purpose, related laws were amended in June 1999 to enable future intermediate storage of spent fuel. Following this, electricity enterprises are currently endeavoring to construct the intermediate storage facilities.

Next, I would like to talk about plutonium management in Japan. Since time is running short, I will refer to some figures, which was published to show the supply and demand of the nuclear fuel cycle in Japan in 1995. Basically, these projections are still relevant.

Figure 1 shows the projection of the annual supply and demand of plutonium recovered domestically from 1994 to the end of the 1990s. "Joyo," "Monju," and "Fugen," are the R&D reactors. Those

Figure 1	
Demand: "Joyo," "Monju," "Fugen," etc.:	Approx. 0.6 tonnes per year
Supply: Tokai Reprocessing Plant:	Approx. 0.4 tonnes per year

reactors consume 0.6 tonnes per year. On the other hand the supply, from the Tokai reprocessing plant, is approximately 0.4 tonnes per year. In this figure, the quantities refer to fissile plutonium.

The cumulative supply and demand from 1994 to the end of the 1990s is given in figure 2. You can see that the demand side is up to four tonnes and cumulative domestic supply is also four tonnes. Again, the figures are given in tonnes of fissile plutonium.

Figure 2	
Cumulative domestic demand from 1994 to the end of the 1990s for "Joyo," "Monju," "Fugen," etc.:	Approx. 4 tonnes
Cumulative domestic supply from 1994 to the end of the 1990s for the Tokai plant and from Pu already returned from overseas:	Approx. 4 tonnes

The third figure shows the annual supply and demand for the years 2000–2010 (figure 3). On the demand side, the R&D reactors consume approximately 0.6 tonnes per year, and the demonstration of faster breeder reactor consumes approximately 0.7 tonnes per year. The full MOX-fueled ABWR consumes approximately 1.1 tonnes per year, while LWRs with MOX fuel consume approximately 2.6 tonnes per year. On the supply side, you can see that the Rokkasho plant is to produce 4.8 tonnes per year, and the Tokai plant only 0.2 tonnes per year.

Figure 3			
Demand		**Supply**	
"Monju," etc.:	Approx. 0.6 t / yr	Rokkasho Plant:	Approx. 4.8 t / yr
Demonstration FBR:	Approx. 0.7 t / yr	Tokai Plant:	Approx. 0.2 t / yr
Full MOX ABWR:	Approx. 1.1 t / yr		
LWRs (MOX):	Approx. 2.6 t / yr		
Total Demand:	**Approx. 5 t / yr**	**Total Supply:**	**Approx. 5 t / yr**

So in this supply and demand this projecion agree. From 2000 to 2010 the main consumption of plutonium is in LWRs. As for the R&D reactors, consumption is approximately one tonne. And on the supply side, it is projected the recovered plutonium by the Rokkasho reprocessing plant is about five tonnes per year. Under this scheme, we can keep the balancing of supply and demand.

To close my presentation, let me say that Japan has been consistently seeking ways to use nuclear energy only for peaceful purposes, and we believe that this is now understood by nations all around the world. We will continue our responsibility in the sincere implementation of the Japan - U.S. Nuclear Energy Cooperation Agreement, which compounds the importance of research, development, and utilization of nuclear energy for peaceful purposes. And we endeavor to make positive contributions to securing energy supply and safeguarding the global environment.

Thank you very much.

Kinji Koyama: The summary of my remarks is that Japan has been seeking ways to use the nuclear energy only for peaceful purposes. The subtitle to my presentation is “the Japanese Perspective on the Peaceful Use of Nuclear Energy.”

Providing for a secure energy supply and protecting the environment is the one most significant issues that human beings will face in the 21st century. Assuming the current level of science and technology and examining this issue from a mid- to long-term perspective clearly shows that peaceful uses of nuclear energy, including the use of plutonium, are indispensable in securing an energy resource. At the same time, the need for the peaceful use of fissile material has reached a level it had never reached before, when considering such issues as the vast energy resources that will be needed in developing countries, the limit of resources of fossil fuel, the greenhouse effect, air pollution, and other effects on the environment.

Meanwhile, such peaceful use of fissile material, particularly plutonium, has a nature of being a "double-edged sword." Since the original purpose behind the development of nuclear energy was nuclear weapons development, we have been inclined to over-emphasize the aspect of its military use, while attaching much less importance on the utility and necessity of the peaceful use of nuclear energy—which may be an unfortunate consequence of mankind's history.

The ways by which an overwhelming majority of states have agreed in order to dissolve to this "double-edged sword" paradox and to promote the peaceful use of nuclear energy are: to fully implement the NPT, which entered into force in 1970; to prevent further proliferation of nuclear weapons; and, ultimately, to eliminate them. Realistic policies which the international community including Japan can adopt are: to retain and enhance the international nuclear nonproliferation regime based on the NPT; to establish the safety of nuclear energy; and to promote its peaceful use.

Now I want to discuss the role of international controls on the peaceful use of nuclear energy. All fissile material possessed by non-nuclear weapon states parties to the NPT is subject to international control through the IAEA safeguards. Fissile material for military and peaceful uses coexists in nuclear-weapon states. The nuclear weapon states' promise to relocate fissile material for military purpose no longer needed for their security to that for peaceful use as surplus fissile material.

Fissile material for military use is not put under international control. Fissile material for peaceful use in Britain and France is placed under Euratom safeguards. As for the other nuclear-weapon states, namely China, Russia and the United States, only a small portion of their fissile material is made subject to IAEA safeguards based on their Voluntary Safeguards Agreements. As such, those materials cannot be said to be under the international control in a strict sense. Also, fissile material in states not parties to the NPT—such as India, Pakistan and Israel—the stocks under international control is very limited, just as in the nuclear weapon states.

The most urgent agenda concerning nuclear nonproliferation is how the fissile material that is not placed under the international control, especially that for peaceful use—including surplus fissile material—can be put under such control.

The Guidelines for the Management of Plutonium, which we have heard about today, play a certain role in improving transparency of plutonium stock in each country. However, as it is a voluntary arrangement, and because it only requires countries to report the amount of plutonium in 100-kilogram units, its efficiency from the viewpoint of nuclear nonproliferation policy is questionable. All countries, including nuclear weapon states, participating in this arrangement should strengthen the guidelines and transparency by disclosing the amounts of plutonium subject to report more precisely, as in one-kilogram units. Other states, including states not parties to the NPT, should participate in the guidelines. The disclosure of the amount of other fissile material, specifically highly enriched uranium, should be investigated in order to increase transparency. To enhance the transparency on fissile material holdings through strengthening and expanding of the guidelines would be the first step to strengthen the nuclear nonproliferation regime and to establish international control instruments that would reduce the threat of nuclear proliferation.

Third, let me discuss measures applied to non-weapon states parties to the NPT, meaning IAEA safeguards. The IAEA safeguards agreements based on the NPT have worked effectively since its model was adopted in 1971. No fissile material for peaceful use, which the State Parties declared so, have been diverted to nuclear weapons or other nuclear explosive devices. This was, in fact, the evaluation of the Safeguards Implementation Reports that the Director General of the IAEA has presented to the IAEA Board of Governors meetings, and this evaluation has been approved unanimously at the annual IAEA General Conferences.

However, the following events exposed the weakness of the IAEA safeguards: i.e., the lack of sufficient authority and measures given to the safeguards based upon INFCIRC/153 to verify the completeness of declarations. One was the undeclared activities, such as the possession of undeclared fissile material and the operation of undeclared enrichment facilities, as found in Iraq. Another case was the suspicion of nuclear weapons development in North Korea.

In 1997, in order to address these weaknesses, the IAEA Board of Governors approved the Model Additional Protocol, which endorses the introduction of additional measures to confirm the completeness of declarations. Thus, the IAEA acquired measures to prevent similar cases from recurring. The Additional Protocol does not enter into force automatically with the approval of the IAEA Board, but comes into effect only when each country individually concludes the agreement with the IAEA. Through “integrated safeguards”—that is, an integration of the traditional comprehensive safeguards and the measures stipulated in the Additional Protocol—the IAEA safeguards are fortified, thereby further ensuring the prevention of the diversion of fissile material for peaceful use to nuclear weapons or other nuclear explosive devices. As a promoter of the peaceful use of nuclear energy and with a recognition of the significance of the Additional Protocol, Japan brought the Protocol into force in December 1999, and continues its diplomatic efforts to encourage other countries to put the Additional Protocol into force as soon as possible.

Let me now turn to the Japanese doctrine on the peaceful use of nuclear energy. Japan not only has few fossil fuels but also lacks uranium resources, and so depends much upon imports of most of energy resources. Therefore, securing energy resources has been one of the vital elements for the country’s existence. Japan has pledged to use imported fissile material strictly for peaceful purposes through the bilateral peaceful-use agreements with each of nuclear material supplier countries, such as the United States, Canada, Australia, France and Britain, and has accepted IAEA safeguards and conducted the flagging controls on all of its fissile materials. Supplier countries have the right, which Japan has accepted, to withdraw fissile material that they supply if Japan violates these bilateral agreements. In addition to the IAEA safeguards, Japan obliges itself to these measures in order to maintain the peaceful use of nuclear energy.

Adding to its contribution of the early adoption of the integrated safeguards, Japan has put all of its sensitive nuclear facilities under more strengthened physical protection measures, and has actively promoted international cooperation for enhancing the credibility of safeguards by introducing new technologies, in such forms as remote monitoring and remote non-destructive assay systems. Last year, at the same time of the entry into force of the Additional Protocol, Japan consolidated its state's system of accounting for and control of nuclear material. Furthermore, Japan has been developing the analytical laboratory where samples from environmental sampling are analyzed—a new technology that played a decisive role in the Iraqi case. Japan pledges its participation in the Network Laboratory in contribution to the IAEA's analysis capability.

Each of these measures has been adopted in order to demonstrate the effectiveness of nuclear nonproliferation measures related to the peaceful use of nuclear energy, including the use of plutonium, and to obtain international as well as domestic support—which is a challenging task for us. Japan would like to leave options for securing the clean energy sources in the future and for contributing to the welfare of the human society, while promoting the peaceful use of nuclear energy and cooperating with international efforts toward nuclear nonproliferation.

Some countries suggest that the use of plutonium for peaceful purposes accompanies high cost, and thus should be called off. However, with today's science and technology, we must leave the avenue of the peaceful use of comprehensive nuclear energy, including plutonium use, for securing the energy needed globally in both the intermediate and long term. Today, when energy resources are available to us, we, the international community, must devote our every resource toward the development of technologies for the peaceful use of nuclear energy, coupled with enhanced safety on the whole nuclear fuel cycle and effectiveness of nuclear nonproliferation.

Thank you very much.

Kevin O'Neill: Thank you. We have a few minutes for questions for our panelists. Yes?

Q: Thank you, I have a comment on the very interesting talk by Mr. Guais. I think that we are all entitled to our choices, but we're not entitled to our facts. Unfortunately we find ourselves in a situation where we've pursued plutonium, and I don't mind if you do it, but I would rather not do it myself because its cheaper if I don't, and it doesn't solve any problems.

But I think it's wrong to suggest that we have only one industrial solution that's working, and that's the closed cycle—the RCR. That doesn't work either; but you still haven't put any of that vitrified glass into the ground, it's awaiting the laboratory work, and the choice of a repository, and it's exploration, just like in the United States. So we have further political problems, and I firmly believe that we should have above-ground repositories. But if we go to the NEA study, there is a 10 percent difference in cost between the open and closed cycle, but a lot of that comes because—just because—the closed cycle has an enormous delay built into it—something like 50 to 60 years before deposited into the ground—and yet, one pays for the deposit into the ground early on in the open cycle.

Finally, in the long-term, Japan is interested in plutonium recycling to conserve scarce energy resources, but it is a lot cheaper to get uranium from seawater, of which there is a vast supply worldwide, compared to the three million-tonne reserve in terrestrial sources.

And as for conditioning and getting the stuff into the ground in a less offensive form, the studies show that it's not the potential toxicity where you feed it to people spoonful by spoonful, but the mechanism of transport through the groundwater. That's the soluble fission products, like technicium 99 and heavy materials like neptunium, which are important. Plutonium just really does not contribute.

So I say plutonium is optional, so long as you do a good job, and pay the costs of caring for it. You're entitled to do it, but I can't for the life of me see why.

Jean Claude Guais: Well, I'm not sure we'll enter into a long debate. Just one point, but that may be my misunderstanding of one of your points. You mentioned that in the NEA study the cost difference of 10 pecent comes only because in the case of RCR the geological disposal is reported to 50 to 60 years.

Indeed, it looks to me like it works the other way. When you look at the various costs that you expend on time on the two solutions. With reprocessing, conditioning, and recycling, you indeed have expenses early. Reprocessing comes early, that's a large—some would say huge—expense coming a few years after discharge. While with the direct cycle you basically store the material for 10, 20 or 30 years and doing nothing more. So, the real expenses in the open cycle are only coming at the end of the period, while in the RCR you have them in the front of it. So the discount rate process mechanism is working the other way around. It's penalizing reprocessing more, because you have the expenses in front.

Q: That's true. The problems with the cost are that the NEA took the very high cost, small volume Swedish approach to the very large cost of the American approach. But in addition to that differential end-costing, they preserved the stuff above ground before ultimate disposal, and didn't have to pay repository cost for the closed cycle until long after the open cycle. You look at it, it's very interesting.

And I have one other point: Reprocessing has contributed thus far 150 person-Sieverts per year, per gigawatt-year of power for reprocessing. That's including the carbon 14, and that's about six people per year committed per year ultimately to die. That's not a large number of people, but that's what you get with the ICRP standard of 0.04 cancer deaths per person-Sievert. Now, BNFL doesn't do that, because they capture the carbon 14, and I hope you will, too.

Jean Claude Guais: Well, I would love to pursue this discussion. The only point on this one is that I believe that the ICRP is now coming to the conclusion—as has most of the radiological protection community—that using the collective dose is not a reasonable way of measuring risks of radiological exposition. So, multiplying those very, very small numbers by the world population does not make very much sense to me.

Kevin O'Neill: Yes, you were next on my list.

Q: Thank you. This is for the Japanese speakers. You said many times that Japan's program is for peaceful purposes, but as far as I've been able to determine over the past many years, Japan has refused to use the information provided by the U.S. government, and specifically the Department of Energy, to affirm that civil plutonium, can in fact be used for weapons. I have been unable to find any on-the-record statements that Japan agrees with this statement, and over the years it has clouded the issue of the weapons-usability of civil plutonium. I'm wondering, in order to be more transparent, is the Japanese government prepared to accept the fact that civil plutonium is weapons usable, and more to the point, are you prepared to accept that statement here and now?

Masayuki Iwanaga: Well, I can't answer your whole question. But my understanding is, that is a question related to our program for the further development of the spent fuel reprocessing technology. Mr. Okaya, perhaps you would be best able to answer this question?

Shigeo Okaya: I don't think you heard the question correctly. That question is whether or not Japan considers reactor-grade plutonium as weapon-usable. That's your question, right?

Coming from Japan, I can say that we in Japan have no experience detonating any bomb. So we can't verify whether or not the reactor-grade plutonium is bomb-usable or not, but we are informed from DOE that it can be used in weapons, so we consider it weapon-usable, yes.

Kevin O'Neill: Are there other questions?

Q: Mr. Guais, you said that the French recycling program absorbed about 40 tonnes of plutonium, right? Now, that is approximately 50 percent of what has been separated in France, or it's not more than 50 percent. Also, it corresponds approximately to the quality of plutonium you have been produced since you put UP2-800 into service.

One gets the impression that Cogema basically develops an industrial logic, which is to say—bluntly—Cogema creates the problem and says, "don't worry, we'll solve it," right? You create the problem of plutonium stock, and then you say "don't worry, because we have MOX to be able to absorb it." Interestingly enough, the plutonium stockpile has been increasing ever since the MOX program started in 1997. So there is a problem somewhere, it seems to me.

The other point was on Melox, because it has been mentioned a couple times, and there's various figures floating around in terms of capacities and throughput. Now, if my understanding is correct, your current license allows you to produce 100 tonnes of heavy metal in this plant. Now, you've got the license to use a BWR line—in my understanding—essentially for Japanese customers. Isn't it correct that for each tonne you produce in that plant right now for Japanese customers, you produce less for EDF? Thank you.

Jean Claude Guais: I'll take the first point as a statement not a question, so I'll leave you with your comments. Regarding your second point on Melox, I am happy to explain the situation for the whole audience.

It is correct that at the moment Melox is running at the rate of 100 tonnes per year, and on top of that, we have the Caderache plant running at 40 tonnes per year, and on top of that there is also the Belgonucleaire/Dessel plant, which is producing 36 or 38 tonnes per year of MOX. So that is not 100 tonnes of MOX, it is more like 176 tonnes at the moment.

The Melox plant is technically capable to be expanded to around 250 tonnes per year. You are correct that the plant is not licensed for that throughput at the moment. But the situation is that Cogema is now applying for a renewed license for the La Hague reprocessing plant. This application is for more flexible reprocessing operations—not for an expansion of capacity, I would reassure you—but for more flexibility in the fuels, such as higher burnup fuels, research reactor fuels and the like.

Once this is achieved, it is our intention to return and solve the problem in industrial terms: we'll go back to the MOX fabrication and ask for a larger capacity at Melox. Again, I said maximum capacity is about 250 tonnes, as was mentioned by David Albright earlier. Thank you.

Kevin O'Neill: One last question.

Q: I wonder if Mr. Iwanaga could enlighten us about the status of the cooperation on the development of MOX fuel between Japan and Russia. We know that there is supposed to be some MOX fuel developed with the Russian Federation to be used in Japanese reactors. Could you tell us what's happening there?

Masayuki Iwanaga: We have two contacts with institutes in Russia. Mr. Chebeskov referred to some of these activities earlier: that is a subcriticality experiment using the BFS at Obninsk. The purpose of this experiment is to confirm the burning of weapons plutonium in the BN-600 approach. Another one is a contract between JNC and RIAR. This is a trial fabrication of three assemblies using the "vibro-packed" process.

The point of the Japan-Russia cooperation is to confirm the feasibility of burning weapons plutonium in the BN-600 reactor. A unique point of this program is that—very rapidly—we can realize the disposition of weapons plutonium in Russia by using existing technology, such as the vibro-packed fuel and the BN-600 reactor. Does this answer your question?

Q: But the plutonium is not to be used in a Japanese reactor?

Masayuki Iwanaga: No, not at this moment.

Kevin O'Neill: Thank you very much. That will conclude our panel.