AIJ New Year Talk

Implications of Japan's Nuclear Fuel

Cycle Development

Marking the opening of this new year, 1988, *Atoms in Japan* conducted its usual new year interview to review and consider the future of Japan's nuclear industry. Three distinguished guests and the Editor involved in the nuclear

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industry discussed such questions as plutonium recycling, aspects of the nuclear fuel cycle and present problems related to nuclear power.

The discussion is presented below in full.

Guests	Mr. Kozo IIDA	Chairman of Nuclear Development Policy Council of the Federation of Electric Power Companies Executive Vice President, Kansai Electric Power Company
	Mr. Takao ISHIWATARI	Vice President, Power Reactor and Nuclear Fuel Development Corporation
	Prof. Shunsuke KONDOH	Faculty of Engineering, University of Tokyo
Moderator	Mr. Kazuhisa MORI	Editor of ATOMS IN JAPAN Executive Managing Director, Japan Atomic Industrial Forum, Inc.



From left to right, Messrs. Mori, Ishiwatari, Iida and Kondoh.

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Mori: The development of nuclear energy in Japan is beginning to move along the lines of a new long-term outlook, it being projected that nuclear power has come to stay and that a greater contribution will be made to international society. Now, at the beginning of 1988, three Japanese leaders of nuclear energy have been invited by *Atoms in Japan* to frankly discuss all problems confronting Japanese nuclear interests.

First, let us see the profiles of the three leaders. Mr. Iida, vice-president of Kansai Electric Power Co. and chairman of the nuclear development policy council of the Federation of Electric Power Companies, is among the most active promoters of the program for industrialization of the nuclear fuel cycle in Shimokita, Aomori Pref.

Mr. Ishiwatari is well known for his past services in the Science and Technology Agency as Director General of the Atomic Energy Bureau and as Vice-Minister for Science and Technology. He is now vice-president of the Power Reactor and Nuclear Fuel Development Corporation (PNC). He is promoting the development of independent technologies and their transfer to the private sector for the industrialization of fast breeder reactors and other new type reactors, as well as the nuclear fuel cycle.

Mr. Kondo, professor of engineering at the University of Tokyo, is in charge of reactor design engineering at the university's nuclear engineering research facility. Recently, when the Long-Term Program for Development and Utilization of Nuclear Energy was drawn up, his services as a brain truster were used to set a course of development from considerations of reactor type strategy and the nuclear fuel cycle.

Mori: We saw an epoch-making event relating to the peaceful uses of nuclear energy last year, as the leaders of the United States and the Soviet Union signed a treaty for elimination of intermediate-range nuclear forces (INF). I believe that from a broad point of view this can be expected to

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have a far-reaching effect. Five years ago, as you know, Chairman Arisawa of the Japan Atomic Industrial Forum appealed to the United Nations general assembly for disarmament, through a document based on a JAIF resolution. The document said that the proponents of peaceful uses could "not really see peaceful uses come to flowering unless nuclear weapons are eliminated." We suggested in this statement that nuclear weapons should be dismantled and the material used for peaceful purposes.

Then the situation began to move in the direction mentioned, and people were taking a keen interest in approaches made from this position.

This was followed by the INF treaty being signed. It is to be hoped that this will have a favorable effect on the peaceful uses of nuclear energy in 1988.

In this sense, the international framework of nuclear non-proliferation remains important. However, the immediate task before Japan is the nuclear cooperation agreement it has with the United States. The revised agreement is yet to be approved, though not ratified in the strict sense of the word. I think we should begin with a discussion on what implications this has for us....

Iida: Governmental efforts have come a long way in the direction you mention. But I believe INF is still a controversial problem for discussion in the next session of the U.S. Congress. And it coincides with the debate on the Japan-U.S. nuclear agreement. There is no knowing what will be the outcome. Even if the agreement is approved, other bills could make it conditional. If they should make plutonium transport practically impossible, it would be disastrous. Since we are fully prepared to undertake this with top priority on safety, we sincerely hope that debate will be sufficient to clear the way for implementation of the agreement.

Since long inter-governmental negotiations have been held for the Japan-U.S. nuclear agreement, the U.S. government should also make it a point of honor to have the agreement approved.

So far that has not been the business of the private sector, other than some approaches to influential Congressional sources who might be ready to show understanding for the agreement. But there are many critics in the U.S. Congress, and I would like to have our American colleagues use their influence to persuade them.

Mori: Yes. I would say it's a very important agreement for both the United States and Japan.

Iida: Since it means a plus to both countries from considerations of nuclear non-proliferation, it must by all means be cleared.

Mori: Yes. One question, among others, is whether we can assure safety, or physical protection, for the air transport of plutonium on its way from Europe back to Japan. This is the point on which we face criticism, and Mr. Ishiwatari is grappling with it with American cooperation. But I don't understand it when I hear fantastic ideas, such as suggest crashing an airplane by way of trial. Did experiments bring you, Mr. Ishiwatari, a realization of some prospects you can see?

Ishiwatari: Since NUREG 0360 has been set up with the understanding that transport casks may actually be dropped by way of trial, our basic understanding is that if casks equal to such a test can be developed, there will be nothing to worry about.

On the other hand, it would seem to me that the spirit that underlies the negotiations for INF elimination is the same as the spirit that motivates Japan to assure safety for the return and use of plutonium. There may appear to be a difference between these two positions, but plutonium is the point at which they meet on common ground. Since Japan has always insisted on peaceful use and safety, I think we must convince the U.S. Congress by all means that this attitude will never change.

Mori: When planning to make crash tests from all angles at the speed of 500 km per hour, laymen, if told that the tests will prove nothing unless they are made at cruising speed, would think that the stricter conditions could better serve the purposes of verification. But that is not the case, is it?

An airplane flying Ishiwatari: normally at 1,000 kph, when seen by its performance, would not suddenly crash at the same speed. Nor is it likely to collide at the speed of 1,000 Since a crash would most kph. probably happen at the airport when the airplane is taking off or landing, accident data have led us to set the standard of 500 kph. The trial target that a collision would cause casks to hit is made artificially not to be changed, and the shock from it, according to some analyses, would be greater than it would be at 1,000 kph. There are certainly apprehensions felt in Alaska. That is primarily a concern of the U.S. government, but Japan is cooperating in one way and another. Anyone entertaining apprehensions will have to be given a satisfactory explanation. For we are the only country to carry plutonium in large quantities and over great distances. There are movements of plutonium in Europe, too, but we must be aware of the fact that we need to have it travel enormous distances over the continent.

A crashed airplane could serve as a big cushion for the casks it carries, and the shock might be lessened for The question is what that them. would mean technically. For military purposes, I have been told that the U.S. is making dropping tests, setting some solid target for casks to hit to see what will happen if they are dropped from 10,000 meters. Congressional actions have been taken to attach additional conditions, which hardly make sense technically. Proposed test methods are not clear enough for us to see how they will actually apply. I understand, though, the argument that they would better serve for the purpose of clarification. That could cause further

Iida: That could cause furth delays.

Ishiwatari: Yes.

Mori: But you are engaged in the next experiment to be made this year,

arn't you?

Ishiwatari: Yes. I am planning to make some better improvements this year.

Mori: It is reported that INF elimination will make 10 or 20 tons of pure plutonium 239 available. Prof. Kondo, what would you do with that if you could have it free of charge?

Kondo: The Soviets at the recent International Conference on Fast Breeder Reactor Systems at Richland, Washington, U.S.A. suggested that INF elimination would release tons of plutonium. They proposed using it in nuclear power plants. It is rare for the Soviets to propose peaceful uses of plutonium. They do have FBRs, but don't use plutonium. Perhaps others in the conference were aware of this background when they applauded the Soviet proposal.

I was told later that even Americans associated with the Sierra Club, which opposes the use of plutonium, have taken a stand for the recycling of plutonium released as a result of INF "elimination."

Mori: The Sierra Club is rather sensible.

Kondo: As a matter of fact, the proposition is not the kind of a thing that has a zero conversion ratio, which could reduce it to nothing if burned. But the likelihood is that it is something acceptable even to environmental protection groups. As I see it, if that is how the utilization of plutonium begins, it could be the beginning of its utilization on a larger scale. For it's something like that that makes things change.

Mori: Is that considerably different? Ordinary FBRs are designed to allow for 70% or 80% content of Pu-239.

Kondo: Yes, is different. But since it is not more than 2% to 3% that comes in for Pu-use in thermal reactors, the content does not count for much.

Mori: So Pu-use in thermal reactors won't go a long way. It would not be enough. I would consider some better use....

Kondo: No. You need to feel free to use it. What is important to do now

is not to go into details, but give an impetus to the use of plutonium as fuel. That is the position we take on the proper utilization of nuclear energy.

Mori: At a time when energy demand is slow to rise and there is an abundant stock of uranium, it may be hard to understand why Japan rushes for the utilization of plutonium. Of course, we are not rushing for it without commercial considerations. But how would you explain our idea for all that?

Iida: That is a question for when we began reprocessing. What is reprocessing for? For one thing, plutonium should not be left as spent fuel, but should rather be separated



Iida

from waste and put to use as fresh fuel, if only to serve the purpose of For nuclear non-proliferation. another, when seen over the long run, uranium is a limited resource that will run out in the future, and if effective use is to be found for it, you'll have to begin working early toward plutonium utilization, so that a certain level of technology will be ready for it. But the fact remains that there has been a string of minor delays in the program from its inception, and now there is a considerable time lag between reprocessing and plutonium utilization. The idea itself has not changed, I believe. So I hope people will come around to the view that plutonium recycling in LWRs is the prelude to the full-scale utilization of plutonium in the future.

Mori: People will get used to the idea....

lida: I hope people will get used to plutonium utilization. It would certainly be more advisable to use plutonium in LWRs than to leave it at the risk of being used eventually for something unthinkable. Americans have been arguing for some time that it would be poor economy to recycle plutonium in LWRs. But that is not convincing enough for us to change the course we have followed so far. I would think that the FBR, for all its delay in development, should be taken good care of as the most promising application for plutonium in the future.

Ishiwatari: If nuclear fission energy is for people to get along with over a long time span, it must be considered in terms of several hundred years, at least. That's why it seems advisable to make an approach run for the use of plutonium so that people can begin to get used to it. It would not be proper to leave it now and argue that it is a little expensive.

Iida: Like nuclear power generation, it's a source of energy brought about by technology and so must be maintained on as high a level as is practicable. Some argue that you can let it rest for a while and resume it when the need arises. But I would say it's not as easy as that to deal with it.

Mori: When we were at work on the Long-Term Program, we had a lot of debate on something like that, as well as the relevant infrastructure, the problem of physical protection and the handling of plutonium, which is quite different from uranium ... In Germany they have stocks of plutonium brought together to one location, and there is one company using it. Perhaps Japanese electric utilities have not yet gotten around to thinking like that, but they may be in need of something like it. I hope they will see what they can do ...

Iida: There was a time when ATRs came up for discussion. Some were arguing that ATRs, reactors different from LWRs, would provide a better use for plutonium in consideration of

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nuclear non-proliferation. But because great cost is involved, ATR projects were reduced to one unit at Ohma

Mori: ATRs did not prove to be successful enough. But plutonium utilization in LWRs should be done at one place, rather than be scattered each for small scale operation ... The Germans get their plutonium brought to one location, money going with it, for use as a centralized system.

Kondo: Yes. They are considering a system like that.

Mori: They hand over their plutonium, along with money, to where it is to be burned.

Iida: In Japan we have PWRs and BWRs. Since plutonium is to be recycled in groups of some ten units, you can't have it take place here and there separately. You have to restrict it to some specific units where MOX fuel can be used.

Mori: The question is which is easier for its use, PWR or BWR. If it is easier to use one reactor type rather than the other, the choice may fall on that. The idea was once conceived that equal use for both types would make up for the poor economic advantages of the reactors.

Kondo: Questions arise as to the way of thinking about the infrastructure. Plans are afoot to see that plutonium is recycled in ten of the 1,000-MW units at some time around 2000. But problems remain over what Mr. Mori has just pointed out, namely the question of economics, as well as that of public acceptance, because discussions are still insufficient on what to do about fuel fabricators. The question whether reactors for the use of plutonium should be centralized or dispersed, as I see it from an international point of view, is not a sensitive matter for consideration in Japan, because it's a small country.

However, fuel fabrication plants are, I think, primarily an economic consideration which could have a bearing on physical protection. So it will be necessary to centralize them. Building such a plant next to a reprocessing plant is open to question. Fuel fabrication plants have so far been allowed to exist without

serious consideration being given from a long-range point of view to the way they should be. The way they are is not exactly the best that can be expected of them. So I don't see why, in the age of plutonium, fuel could not be fabricated in some different fashion. I do not intend to insist, but I would suggest that some longrange concept should be established that will rather use physical protection and other considerations as the reason for arguing that efforts should be made toward centralization in pursuit of economic advantages. Lowering fuel costs is an important problem to be resolved in the years ahead. When I hear some argue that fuel rods, after being turned out at the place where they are manufactured, should be moved again for use somewhere else, perhaps either in the vicinity of PNC installations or in Shimokita, I wonder what sense of management they have. I presume it is an argument of those who cannot think in terms of a long-range concept.

Ishiwatari: The circumstances are such that you can hardly make it understood that "plutonium will become tangibly centralized as a necessary consequence, or will be brought under a proper form of control, and never will be aimed to centralize facilities for MOX fuel fabrication."

Iida: Interest centers on the fact that plutonium is contained in MOX fuel. If you tell people that "plutonium covers a considerable portion of the LWR fuel in service," they are startled. Even if the quantity contained is different, they say, "It makes no difference how much there is." It is something beyond their understanding, and they regard plutonium as a problem that has cropped up suddenly.

Mori: Some quantities are actually burning now.

Kondo: If I can add something to what I have just said, I'll say that, with regard to uses for plutonium, the social circumstances in Japan are such that industry leaders may not have misgivings about fuel fabrication plants being scattered around this country. But the question remains if this can be an example to the world. I would think this is the most important point we'll have to consider for the future. Japan is going to set a precedent as the third country after France and West Germany to utilize plutonium. So we must build a system that will be acceptable to average society, if we are to discharge our responsibility as a predecessor.

Ishiwatari: That reminds me that Japanese society is a little different.

Mori: That's true.

Ishiwatari: So I feel there is a gap in the way of feeling or thinking about physical protection. This is a problem to be tackled from a global point of view.

Mori: Do you feel from your position, which actually gets you involved, that there is a $gap^{1/2}$

Ishiwatari: We can hardly think other than in logical terms limited to small areas around us. I am afraid we might eventually be carried away by our everyday concerns.

Kondo: You have a good initial design. In other words, you take care to build a complete system whose day-to-day operation will not become a matter of concern. Let me say again that I think that is an important point. It is the idea of building a system that will not become a matter of concern later on. So far, that has been considered, for some reason or other, independent of the problem of reprocessing. Now, when you take the economics of a total system into account, considerations of physical protection will probably lead you to see the merit of centralization. Since one major reason we have to show to international society for deciding to utilize plutonium soon is the economic advantages that it will bring, considerations of physical protection and economic performance will naturally bring us a fuller realization of what kind of precedent we should set to the world.

Mori: Yes.

Ishiwatari: Since Japan is a major energy-consuming country, I think we should accept the responsibility of Japan to human society for using more energy than most others. So we must do our best to win worldwide understanding of the idea that we should redouble our technical efforts to find uses of energy that come through the application of technology.

Kondo: And we are not the last nation to do this. There will probably be a lot of other nations to follow suit, and they will see us as setting a precedent ...

Mori: Because we proceed from considerations that go that far, we

may have ample grounds for winning international confidence.

lida: Yes, we may. That's why we must be fully aware of the fact that we are contributing.

Mori: That's so. In the face of the great restrictions placed on us by the United States, we have so far been on the defensive in our argument that Japan is different. It's about time that Japanese realize their psychological growth and develop their awareness for what you have just said.

Mushrooms after Rain:

Enrichment Processes Crop Up

Mori: Let us proceed to the next subject. When we were about to go ahead with the gas centrifuge process, making machines out of steel for uranium enrichment, a new material confronted us, in the development of carbon fiber. That made laser processes available in AVLIS and MLIS. Then a chemical process joined them, all running parallel with each other.

Iida: The gas centrifuge process was tackled under PNC guidance, but the other processes cropped up like so many mushrooms after rain. Among them is the chemical separation process.

Mori: That appears to be arousing attention in the western part of Japan.

Iida: The chemical process, which was in the background when the Long Term Program was under study, came into the open soon after the study ended. The likelihood is that it will actually come up for consideration. Asahi Chemical Industry Co. researchers grappling in earnest with this process hold out high hopes for it. I think they may fairly be given credit for that. But I do not relish the idea that electric utilities should immediately finance research for it.

On the other hand, research on the AVLIS process have begun in the form of an association of researchers in the private sector, but this is a very difficult task.

Mori: Arrangements exist to continue the study of the two laser processes for another three years before its results can be summed up in 1990 for comparison and evaluation of the AVLIS and MLIS processes.

Ishiwatari: That's right. Hopes are held out that it will produce enough results by 1990...

Kondo: I find the study very interesting because it reminds me of the time when we decided to take up uranium enrichment. We had a tragic resolution or something like that when we moved into the business on the strength of the presence of a giant seller, or with the understanding that there would be some demand for what we could offer in Japan. Now that several new candidate technologies have appeared, as you say, there is no doubt that enrichment is in the course of technical development. There can be no better chance for a new entrant into the market. It is a matter of congratulation for newcomers that the later they come the newer the technology with which they can start business. Since they are favored with this blessing, they are advised, for all the adjustments that may be required to improve this opportunity, to take care not to miss their chances. Of course, this may be a matter of consideration for businessmen.

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Since technology finds a buyers' market, it is the sellers who have to take risks to push it ahead. So there is no choice but to follow the rule that the weakest goes to the wall. For if you start a social welfare service in such a way as to please everybody, you might miss your chance.

Mori: That's true.

Iida: As has been pointed out, we already have plans on hand for the gas centrifuge process, with machines for operation in the process, and then for the laser process as well. We each have goals to reach, such as the approximate time when they should be introduced. Now, if the chemical process comes in, confusion will arise over the question where it should take its place. I would think anything that is cheap enough should be allowed to have its way. However, Japan has a well-laid long-term program, as befits its wellknown skill at doing things systematically. Introducing the chemical process would throw it into confusion again.

Ishiwatari: It would be difficult to let everything have its rightful place.

Kondo: Europeans, notably Germans, are more sensible on this point, as they classify technologies, some for introduction in their own country and some for transfer to, say, Brazil. It would seem to me that the problem with us is our readiness to "do everything in Japan." I don't see why a bilateral or multilateral joint venture could not be considered for some of our technologies.

Mori: The Germans, however, on one hand say that they will not take it upon themselves to work for Brazil, and on the other, continue to do fundamental research to the extent of honoring their commitments to that country. That reflects credit on them. In Japan, when we decide to quit, we quit everything. We go to the length of scrapping all the machines we have ...

It may be necessary to allow for the continuation of some fundamental research. This could help us let everything hold its right place until the time comes for adjustment.

Ishiwatari: Perhaps maturity has

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not arrived yet for the management of technological developments. To our regret, Japan does not have enough experience.

Iida: Uranium enrichment has been started in Japan because it needs it for reasons of security. It's not because it gives us greater economic advantages. I would think there should be more latitude to allow for it so that security can take priority to some extent, and beyond that, economics should be taken into account.

Japan is supplied with enriched uranium not only from within the country, but also from the United States and France. Japan is often approached with foreign offers of enrichment services. So we are in the position to compete for economic advantages. I feel the chemical process could also be listed with what we may have to bring into competition. Our task for the future is to consider what arrangements should be made to make it possible.

Ishiwatari: The task comes up because the time has come when we want to sell. Perhaps the time during which anything the Japanese wanted to buy was hard to come by was too long for us to free ourselves of our past habit and begin to exercise our judgment.

Costs for Industrialization of Fuel Cycle

Mori: The construction of three nuclear fuel cycle facilities in Shimokita is under the supervision of Mr. Iida and his organization (FEPC). Is it going as planned?

Iida: Yes. It is on course for its destination almost as scheduled. Although it appears some minor changes have to be made to allay opposition from different positions around us, as is the case with most other projects, everything is going almost to schedule.

Mori: Has any progress been made in clearing the way for the transfer of technology? I hear once in a while Chairman Arisawa say that everything should be integrated, or ask if everything is going all right. Do you find it's getting better?

Iida: Most distressing are the problems of cost, because the more you discuss it the higher it rises. The cost will skyrocket if it is left without taking the economics of the project into account. Starting with its building cost at \$700 billion, you find it rising to \$800 billion. Since you can't leave it to go up further, you must do something to stop it. For this, one has to be more careful about technical examinations. Because we are working on the first technology of this kind to be introduced into Japan, the designs for it must be reasonable.

On the other hand, safety is a major consideration. The trouble is that there are still problems on the assurance of safety. Except for some uncertainties still to be cleared up in this respect, we are on course for the goal.

Mori: The other day, when I went to Ningyotoge after a long time, I found the new Demo enrichment plant there is designed to ensure efficiency.

Ishiwatari: Yes. It's a very compact plant.

Mori: Does architectural engineering count for something in that?

Ishiwatari: I think it does. Now some people involved in the Shimokita project point out with highsight that more foresight should have been used for speeding up development.

Mori: We have few architectural engineers in Japan. Power plants can be designed and built under the existing system, which plant suppliers do in their capacity. But they may not be adequately equipped to work on the nuclear fuel cycle, if it is to be rationalized. I think someone else should be on hand to help them. For if you let everything end as an aggregate of so academic circles. According to specialists sent by JAIF to a recent international meeting, the planning of countries seem to be at cross purposes. Some suggest recommending one type to developing countries, and some say they are looking for something "intrinsically safe and free from danger," in consideration of the opposition aroused by Chernobyl. There is great diversity of opinions.

Seeing that Japan has large-size generating plants in steady operation, there may be no need for this country alone to get busy on new types, at least if it is an LWR type. But we might well try new ideas if they serve technical development and for safety. It can't be taken to mean that what we have now is dangerous. But what would you gentlemen think of this proposition? I presume medium and small size reactors, as well as safe reactors, are being considered by some ten committees here and there in Japan.

Kondo: Proponents of medium and small size reactors have advanced the idea with a view to discussing how the nuclear industry can open up a new market under present circumstances. The idea is based on the advisability of developing countries, as well as industrialized countries, considering smaller reactors as their choice for future construction. But IAEA and surveys conducted so far put the market for the years through 2000 as 10 to 15 units. In this case, it is necessary to study if they are economically feasible or not. Available at present is a reference to their competitiveness compared with coal. This does not seem to indicate the best that can be expected from reactors, though no definite findings are possible unless they are compared in power generating costs at the receiving instead of the sending end. It is reported that in the United States a questionnaire addressed to some 300 companies has revealed that such reactors reach a peak level with a capacity as low as 100 to 400 MW.

But a question arises as to whether that is desirable or not. It is two years since TVA stopped all its plants. For all that, is it wise strategy to let more companies there have reactors under the conditions of American society for nuclear safety? The world will not have suppliers following a simple variation of current business practices that allow them to sell reactors on condition that cancellations, delays in terms of work and everything else are left to the responsibility of those who buy them. But at the same time, that is exactly the sales point they might like to make. From now on, they would like to make you feel free to buy a plant because it works even if your level of skill is not high enough to control it. The second point is this: That nuclear technology should become equal to conventional technology. I could even say that this in itself has meaning. In Japan, too, it is most desirable for us to build a plant that is as operator-free as possible, and at the same time, safe. It might be important to explore to find a technology in this sense. But I am not so sure that this has to be linked immediately with the idea of finding a market for it. It has been a customary practice for the Americans first to place their wares on the market and then get to work on them if there are problems.

But in Japan, we take our time in doing research, because we want to build to the highest point of technology for our light water reactors. As a result, if something a little smaller proves necessary or practicable, we will add it to our agenda. That's the way it's desirable for us to move ahead, I think. First, we should discuss what it is that we have to thrash out as a checkpoint or strategy. Of course, some may argue that the important thing about research and development is first to "let all flowers bloom," so that all ideas can be assessed, and since we are at that stage in our search, we don't have to worry about all the propaganda it may entail. But I would say that if efficient discussion is to be promoted, at least for the purpose of administration, then more points should be set out in a point-by-point study.

Mori: Does FEPC also have a com-

mittee?

Iida: No. We are not actually studying the questiion of safety of medium and small size reactors. The Japanese electric utilities are convinced that their nuclear technologies have attained full growth. It's all very well to seek greater safety, they would say, but they cannot see themselves facing such empty questions as "Is what you have now unsafe?" Even more, they won't have us making smaller reactors. This is because, under the Japanese conditions of location it's no easy task to build a unit, large or small. Since conditions for building a unit are the same whether it's 1,000 MW or 300 \sim 400 MW, they say, "Except where there must be a small unit, why don't you put a large one where you can?" If the proposition assures enough safety for a larger unit to be built, or could lead to the study of something like that, then they would join in the study. But few of my company officials, at least, are ready to join the project to build small ones.

But when I think of developing countries planning to introduce nuclear power, I would propose that Japanese manufacturers advance their studies and prepare to supply the technology — but not merely for sales purposes — to countries that may need it. This is the sense in which I am recommending it.

Kondo: At a Probabilistic Safety Assessment (PSA) symposium held in Tokyo in December, we were given the first data to be made available on the engineering system reliability of a Japanese plant. They said, "Reliability cannot be calculated." They put it the wrong way. They meant that there is a denominator with a numerator coming to zero. As a result of engineering efforts built up, there are no conditions under which engineering safety facilities cannot eventually be available during plant operation; this is what the data means. They have got us that far.

It can safely be said that technology or maintenance has now reached the stage of assuring absolute safety. That's why, if anything inherently safe is to be built, it will be little more than what we already have. The point is that all we can do now is just to employ some other methods, or make use of physical phenomena, to produce simplified equipment and put it to use. If this is possible, or if something like

it serves to explore further possibilities, that is the way technological progress can be made. That's worth going in for in a big way, but it does not mean any improvement in safety levels.

More Flexibility for HTGRs

Mori: There was a time when hopes were held out that high temperature gas-cooled reactors would also be used for iron and steel making, for purposes other than power generation. But the steam has gone out of it, and JAERI researchers at work on the HTGR have changed its name to an engineering test reactor, scaled it down, and got down to work on it as the most important budget item for fiscal 1988.

The gas-cooled reactor has some characteristics that are conducive to inherent safety. But the circumstances are such as to preclude the reactor being played up and leaving it halfdone. I have done what I can to support it. But I must recall how hard we have had to work even to get the LWR to develop to what it is. If work is to begin on the gas reactor now, aiming to find use for nuclear energy in making iron or producing hydrogen in some 50 years' time, we must now have some of what will be technically necessary then. It won't be in time unless we start on it soon. JAERI researchers are advised not to say that they are going to build "a Japanese reactor that will be different from foreign reactors," but are requested to work toward "something that will work for sure."

The other day I said to them, "Why don't you change to pebble type fuel?" Pebble fuel is in use with most others in the world. Only the Japanese are using pin-in-block type fuel. I told them, "stop trying to do it your own way." They they said, "If you went too far with your suggestion, you would make it hard for us to get sufficient budgetary appropriations." But they have agreed to

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"allow sufficient flexibility in the project to include pebble type as well."

Kondo: So far as JAERI is concerned, I understand that the way the institute is moving ahead with its project does make for more flexibility.



Kondoh

Since the reactor was changed to serve engineering test purposes, it has become a test reactor with its core designed for in-pile testing, so that pebble type fuel can also be tested in it. In this sense, before finding out everything about the capabilities of their reactor type, they have made adjustments with the understanding that they are advised, at the present time, to have a reactor capable of being used for all kinds of tests. My understanding is that this is what they should have done from the beginning.

Ishiwatari: What Prof. Kondo has just said is exactly what we are advised to do at this point.

Mori: I'll be glad if that is the case. But I wouldn't like them to take their time just because there is no actual demand yet. It's no easy matter to build a new type reactor and bring it to the point of practical application.

Kondo: I might suggest the desirability of the reactor core having a little higher capacity. An output of 30 MW is a little short of what is desired, but there is no help for it now. I would rather hope that all possibilities will be explored to use it for tests on inherent safety and other matters.

Mori: Scores of years from now, if there should be provision for a constant supply of gas at a temperature of 800 degrees or higher, with ceramic and gas turbines making technical progress to go with it, then such new technologies would naturally be incorporated. For this purpose, we'll have to be equipped with something equal to the job. Our experience with LWRs shows there will be no point in doing anything if it is to be kept within the limits of laboratory research.

Now what about the FBR?

FBR Development in Europe and Japan

Ishiwatari: With the practical application of FBRs scheduled for some time around 2030, there seems to be ample time for research. But a stringent condition has been attached to the reactor, calling for it to become "equal by that time to the present competi-

tive position of LWRs." Considering that the time when new technologies have to be developed and incorporated in the development projects is thought to be some 20 to 30 years, I see less and less test reactors than will be needed for FBR development. I am afraid there may not be sufficient numbers by the time they will be needed around the world. This should be a matter of concern; it could delay the process of FBR development.

Mori: "Joyo" may go some way to meet this need in Japan. The Americans have something, too, don't they?

Ishiwatari: May be. But I wonder if they are ready to build a new test reactor when their existing one is worn out.

Kondo: It is important to take that into consideration. Perhaps the biggest task for the immediate future is to remodel JMTR. And then, what are we going to do about "Joyo"? Is its performance to be improved? If so, it will be hard to maintain, I suppose, unless it is used partly for power generation. There is need also to consider the possibility of international joint operation. Constructing and operating a research or test reactor could be one of the best forms of technology transfer to developing countries.

Mori: Yes, it could be of value worldwide.

Ishiwatari: International cooperation will not work out unless there are substantial arrangements for countries to continue cooperative relations I am beginning to realize that any country shutting itself up would make others feel ill at ease.

In France, since they had trouble with their Super Phoenix, they have apparently changed their point of view, and are taking a wait-and-see As I see it from Japan, attitude. France and all other European nations including Germany and Britain, are falling into line and keeping pace with each other in their FBR development tempo. At the risk of deceiving myself, I might say they are coming close to the development tempo that is conceived in Japan. I feel the future will open a better prospect for international cooperation.

Iida: The gas-cooled reactor came up for discussion when the Long Term Program for Development and Utilization of Nuclear Energy was being revised. Discussions ended in general terms; they revolved most of the time on whether various reactor types should be allowed to exist, or whether a limited range of reactor types should be selected for construction. As it turned out, the opinion gained ground that "efforts should not be allowed to shoot off in all directions, but be concentrated on LWRs." The time was bad for the HTGR project, as the slump in the steel industry and other unfavorable conditions combined to make things tough for it. Now that the project has been scaled down to a research reactor, it is coming to life again.

Mori: Although something is wrong with the HTGRs in Germany, the Soviet Union and the United States, they are continuing development there

Ishiwatari: It may be advisable, if possible, to allow ample latitude for research and development. Generally speaking, I would say that normally there ought to be a choice to be made from many.

Mori: Is PNC prepared to go on operating "Fugen" and "Joyo"?

Ishiwatari: "Joyo" has actually been in service for about five years. It still offers good prospects. It has the potential of effectively helping FBR development.

Mori: What about "Fugen"?

Ishiwatari: I think it has an important bearing on the Ohma Power Plant project. I think it must be kept going to support the foundations of research and development necessary for the project, but it won't be long It's getting so the PNC organization can hardly take care of it.

Mori: Some restraints on it may keep its generating costs from going up excessively.

Ishiwatari: Yes. Barring personnel



Mori

and depreciation costs, operations break even between running cost and revenue from electricity.

Mori: It's a matter of a little more than ten yen being charged, isn't it?

Ishiwatari: Yes, a little more than ten yen. Now that that's the way of it, we'll have to figure out what to do next.

Mori: If you could get it a little rationalized

Ishiwatari: There would be no point in operating it just for personnel training for Ohma. I think measures will have to be taken for some modification in the form of operations. In fact, we need manpower for the prototype FBR "Monju," too. It is hard to find manpower to recruit now. But I'm sure there will be some proper solution to that.

Mori: As PNC is undergoing a change of character, I believe legal questions will come up for discussion in 1988.

Ishiwatari: Mindful of all the charges that have been brought against us, we will take the line of achieving consensus in some way.

International Exchanges of Information

Iida: Attention is focusing this year on the proposals made for nuclear countires by Lord Marshall of England.

In particular, there is general agreement that Japan is going to play the central role in Asia. But Tokyo has been fixed as the center of Asian areas with no arrangements made as to what countries will rally around it. I think this is something which we must work on from the beginning of this year, to obtain general understanding. It would be out of line with the proposed rationale if it turned out to be an Asian bloc comprising no countries other than Japan. I am suggesting that we Japanese should use our efforts to invite others to participate on the understanding that all countries should join because their safety is at stake.

Mori: I feel sure they will understand.

Iida: It seems that the next general meeting is going to take place in Moscow in this coming autumn. So arrangements for Asia will have to be completed by then.

Mori: I am planning to arrange for the JAIF Annual Conference this year to hold a session that may arrive at a conclusion, such as to see "something necessary and worth going in for, and in which Japan should take the initiative."

Iida: What is going to be done specifically is still to be discussed. Mori: Don't you have concrete

plans yet?

Iida: A working committee is at work on it now. Japan is represented on it. Probably questions will arise as to what information is to be distributed, how to keep countries informed, and then questions concerning personnel as well, like the possibility of promoting personal interchanges... Everybody is speculating differently, and none of their questions has been thrashed out yet, and none will be thrashed out until all countries come into line as an Asian bloc. They will not have Japan taking the liberty of framing a program and then trying to bring others in on it.

Ishiwatari: In Japan, a clear distinction is made between public and private sectors, as they divide roles between them. But this won't go for other countries if you approach them on the same line of thinking. I really appreciate the trouble you take in the face of problems affecting international politics, because trifling slips could throw them into confusion.

Kondo: I have another matter of concern. It is that recent trade frictions have brought the call for the "open-door principle." I'm afraid it might eventually be extended to affect electric power as well. In addition to the construction of an airport, tenders might eventually have to be invited for the construction of a nuclear power plant.

Mori: I'm thinking of something to the contrary. A Japanese electric power company might build and operate a power plant in America.

Kondo: That could be just as good. Mori: An American friend has told me that that could be "the best way to revitalize America."

Ishiwatari: Many American holding discussions with us these days on science and technology propose a symmetrical approach, or ask us to "proceed on an equal basis." Among other things, nuclear power is perhaps close to what they want to share symmetrically with us.

Mori: Taken as a whole, it is, although some sections appear to be closed to participation.

Ishiwatari: I think it is the way of thinking that Japan should follow positively in regard to nuclear power.

Mori: It could well be restricted to things that are really reliable. Not

everything can be imported just because it is cheap.

Iida: The way things are with nuclear power in Japan, the costs are too high.

Ishiwatari: The appreciation of the yen against the dollar, which is a matter of numerical calculation though, is beginning to have a tangible effect. Since the exchange rate is as it is, it can't be helped, though

Kondo: It's going to be a problem of far-reaching consequences.

Ishiwatari: I believe nuclear power is a very good example for us in learning to make an international approach. But it will still come under attack as it makes progress. It's probably being watched in ways that we do not learn about.

Mori: Maybe.

Iida: Actually, during the height of the trade friction, the pressure came on us hard to buy nuclear equipment. Offers came from Westinghouse, too. When political and other tough problems remain unresolved, it's the big companies that come under attack.

Kondo: However, Japan has its safety philosophy. For example, what all IAEA or OECD discussions in principle narrow down to is the argument that something like Japanese safety culture should come to stay. I feel that Japan has accumulated enough experiments and experiences to begin making our contribution to international society this year. The most common things that can be communicated easily among the Japanese will have to be explained deliberately until they are brought home to international society.

Mori: Thank you all very much for your frank and valuable discussion.



January 1988

Fiscal 1988 Draft Budget for Nuclear Energy Up 1.9% to ¥369 Billion

At the cabinet meeting held on December 28, the government approved the fiscal 1988 draft budget, with a general account of \$56.6 trillion. The nuclear energy related budget is \$181.124billion from the general account and \$186.098billion from the special account for power sources development, totalling \$367.222 billion, up 1.9% on the previous year. Of the proposed nuclear energy related budget, the breakdown for the six government ministries and agencies, including the Science and Technology (STA), the Ministry of Trade and Industry (MITI), and the Ministry of Foreign Affairs (MOFA) is shown in Figure 1. The largest appropriation goes to the Science and Technology Agency totaling \$271 billion. The STA is promot-

Table 1	FY	1988	Governmental	Nuclear	Draft Budget
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Governmental Organizations Items	Science and Tech Agency	nology	Ministry of International Trade and Industry	Ministry of Foreign Affairs and Others	Total
General Account	GG 33,894 176,407 (98.7%)	(GG 36,299) (178,811)	251 (254) (98.8%)	4,466 (4,243) (105.3%)	GG 33,894 (GG 36,299) 181,124 (183,308) (98.8%)
Special Account for Power Resource Development	GG 79,410 95,083 (100,6%)	(GG 82,060) 94,552)	91,014 (82.363) (110.5%)		GG 79,410 (GG 82,060) 186,098 (176,914) (105.2%)
Power Resources Siting Account	15,032 (119.3%)	(12,596)	64,463 (55,518) (116.1%)		79,495(68,114) (116.7%)
Power Resources Diversification Account	GG 79,410 80,051 (97.7%)	(GG 82,060) 81,956)	26,551 (26,845) (98.9%)		GG 79,410 (GG 82,060) 106,603 (108,800) (98.0%)
Total	GG 113,303 271,491 (99.3%)	(GG 118,359) (273,363)	91,265 (82,617) (110.5%)	4,466 (4,243) (105.3%)	GG 113,303 (GG 118,359) 367,222 (360,222) (101.9%)

(Unit: ¥ Million) GG: Government Guarantee for Appropriations for Ensuing Years

* Parentheses show the budget for fiscal 1987.

ATOMS IN JAPAN