An Acceptable Future Nuclear Energy System

Condensed Workshop Proceedings

M. J. Ohanian, Editor

Institute for Energy Analysis • Oak Ridge Associated Universities

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Foreword

A year has passed since the Gatlinburg workshop to outline an acceptable future nuclear energy system. The world of nuclear energy today looks very different than it looked then. The United States has imposed a moratorium on fuel reprocessing, the Carter administration has cancelled the Clinch River breeder reactor (although this action is still being contested in Congress), and a renewed commitment has been made to deal with radioactive wastes.

All three of these considerations were placed on the table at Gatlinburg by "opponents" of nuclear energy as the sine qua non for maintaining the nuclear option. The question is whether these actions will prove sufficient to allow the nuclear enterprise to unfold. It is my own view, reinforced by studies that have been conducted during this year at our Institute for Energy Analysis, that we must still deal with other institutional and technical questions, many of which were mentioned at Gatlinburg, before we achieve a workable consensus on nuclear energy. High on our list is siting policy. The increased difficulties encountered in finding new sites seem to militate toward a gradual, de facto acceptance of the idea of confining the nuclear enterprise to as little land space as possible. It is too early to judge exactly how such a policy might be implemented and exactly what form it should take. But that this seems to be the

trend, in other parts of the world if not the United States, is unmistakable.

I would like to thank all the workshop participants as well as the staff of the Institute for Energy Analysis who gave of their time and energy in this attempt to devise a rational course. Particular thanks are due to Professor M. J. Ohanian who worked tirelessly managing the conference and editing the transcript.

Alvin M. Weinberg
Director,
Institute for Energy Analysis

Note from the Editor

The verbatim manuscript from the two-day workshop consisted of 500 pages. The problems of publishing a verbatim text are numerous and obvious. Great care was taken not to alter the context of statements and discussions while yet publishing a coherent, manageable, condensed transcript. We have also tried to preserve the individuality of participants' statements. A goal of the workshop was to create a setting for voicing and discussing divergent views; we hope this volume will further that goal.

M. J. Ohanian
Editor

Dr. Ohanian is a staff member of the Institute for Energy Analysis on leave from the Department of Nuclear Engineering Sciences, University of Florida.

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Session I

General Issues

Statement

Alvin M. Weinberg, Institute for Energy Analysis

I should start by telling about the background of this meeting. Those of us who are in the nuclear community, and indeed many who are not, but are interested in the question of energy, have become increasingly concerned about the great debate on nuclear energy.

About a year ago [1975], several of us at the Institute for Energy Analysis [IEA] raised the question of whether it was possible to outline a course of action that would in one way or another resolve this great debate. What we are seeking here is some possible solution of what began as a polite debate and has taken on the aspect of a guerrilla war.

We conceived, then, the idea of making a study of the terms for an acceptable nuclear energy system. And we did receive permission from the Energy Research and Development Administration [ERDA], our sponsoring agency, to study the question with the idea of publishing a report sometime in the future.

We had conversations with a number of people in Washington; we discussed the matter with Bob Seamans,[1] with a number of people in Congress and in industry, and with some who are in varying degrees opposed to nuclear energy.

[1]Robert C. Seamans, Jr., was the chief ERDA administrator.

It is true that we received not only less than lukewarm endorsement from some, but indeed we received hostility towards the whole idea from others. On balance, we thought that we had nothing to lose and that there might be something to gain in holding a workshop as the initial step in this larger study.

Therefore, as far as the Institute for Energy Analysis is concerned, we intend to use the results of this workshop as a means of identifying points of departure for this broader study, which is labeled "Outline for a Long-Term Acceptable Nuclear Future."

We had a problem in deciding whom we should invite. The primary requirement that we, more or less explicitly, insisted upon was that all of those who attended the workshop be prepared to accept the notion that under some circumstances a nuclear future is acceptable.

The purpose of the workshop, then, is not to debate the acceptability of nuclear energy, but rather—given the necessity for some kind of nuclear future—to explore the kind of future that can be made acceptable and can be the basis for bringing together the various sides in the big confrontation that is now going on. In setting forth this explicit requirement, it is undoubtedly true that some people who would otherwise have attended the workshop were unable to do so. We did, nevertheless, try to balance the viewpoints. As I look around the table, however, I fear that, for reasons with which the management of the workshop had little to do, one finds that the number of friends of nuclear energy and the number of those who are not so friendly towards nuclear energy are not really in balance.

I think it is very useful to have a discussion that takes as its fundamental premise the idea that we cannot do without nuclear energy. The reasons are indicated, basically, on the first page of the paper that Jack Ohanian and I have sent to you (Appendix A).

First is our conviction at the Institute for Energy Analysis—on the basis of a variety of studies we have made—that the total world energy system will increase substantially from roughly 200 quads to something between five and ten times that within, say, 100 years.

That increase is largely governed by the increase in population and, to a lesser degree, by the expansion in human aspirations and the increase in living standards.

We have begun studying the possibilities of using the other renewable resources—solar and fusion—to pick up the major part of this burden. The conclusion we have come to is that there are great uncertainties when one speaks of energy systems as large as those we are speaking of here. I will not go into the reasons for all of those uncertainties; let me simply mention that a solar system that is the sole energy system is quite different from a solar system with a firm backup.

With respect to fusion, we have an agnostic position. But our purpose here, we believe, is to prepare for the worst contingency, which is that fusion may not work.

With respect to conservation, the world of 1000 to 2000 quads in a certain sense is already a world that has lots of conservation if one makes the ultimate assumption that the big disparities between rich and poor are too unstable to allow the world to live with them over a very long period of time.

The final point is one that has come onto the scene only recently, but one which is becoming increasingly a matter of concern. It is this rather spooky question of a carbon dioxide catastrophe. I have just returned from a meeting in Berlin at which were assembled about 50 representatives from some half-dozen different fields of expertise: climatology, oceanography, ecology, forestry, economics, energy strategy, and geochemistry. The subject was the general question of man's intervention in global geochemical cycles, with most of the discussion being concerned with the carbon dioxide cycle.

Professor Flohn,[2] who is a very distinguished climatologist, pointed out that the energy that is driving the climate—the energy that is involved in the winds—is of the order of 1200 terawatts. That is only 1 percent of what the sun sends us. He further pointed out that man's waste heat at present amounts to 8 to 15 terawatts, and the carbon dioxide that is now being thrown

[2]Professor H. Flohn is on the faculty of the Meteorologisches Institut at the University of Bonn.

into the atmosphere is increasing man's heat budget by something on the order of 1.5 terawatts per year. This means that if the carbon dioxide budget continues to increase at that rate, man's heat load on the atmosphere in some 50 years will be within 10 percent of the energy that is driving the climate. And Flohn's assertion is that this could cause unacceptable changes in the climate.

Now these questions are fraught with much uncertainty. The main point is, however, that under the circumstances it seemed to us very imprudent to plan for a future without nuclear energy. The most prudent course would be to try to find out whether there is not an acceptable nuclear energy future since man may simply be driven, regardless of any other consideration, to the use of nuclear energy.

From the responses we received, the major, and perhaps the underlying, disagreement that I was able to discern was on the question of whether it makes sense, given the huge uncertainties implicit in any projections of a long-range future, to even try to visualize such a future. Would it not be much more sensible and much more practical to simply allow nature to take its course—to allow evolution to move along what would be, I suppose, the path of least resistance—and fix things as we go along?

In other words, in trying to articulate so explicitly a long-range future, one could perhaps be leading the whole society down a path that is just very, very wrong. Would it not really be much better to allow society to evolve its energy and nuclear energy systems without such explicit attempts at visualizing what we really cannot visualize?

Even though I have much sympathy for this view, I cannot help but feel that if some 20 or 30 years ago we had taken seriously the possibility that nuclear energy really would be a very large enterprise, we may have done things rather differently. For example, there is no reason, in principle at least, why we could not have had 15 years of experience by now with the permanent disposal of high-level radioactive wastes. I also think that had we taken the possibility seriously, nuclear energy in its civilian embodiment would be as large as it now is,

and the uranium crunch we are now experiencing would have been dealt with more expeditiously.

So despite the obvious advantage of doing things incrementally—and in a sense that is really the only way we plan for the future—I have this almost mystical belief that it is not an idle exercise to try to visualize what a long-range future is and then to work backwards to see whether the courses we are now on are likely to move in one or another direction.

Let me then say how I personally have looked at the matter. (I do want to make it very clear, however, that the purpose of this workshop is not simply to criticize the ideas presented in my draft paper, "An Outline for an Acceptable Nuclear Energy System," which all of you have received. Indeed, many other ideas will be brought up in the discussion.) My own estimate of the situation goes like this: Ever since the beginning of nuclear energy, it has been clear to all of us that it would develop in two phases. Phase I is based on burner reactors and is self-limiting because we simply cannot "burn the rocks" with burner reactors. It is estimated that we have 3.5 million tons of uranium with above a few hundred parts per million natural uranium concentration that is, therefore, more or less practically usable in burner reactors. If we use this uranium in pressurized water reactors, Phase I will provide about 25,000 gigawatt-years of electricity.

Because Phase I is self-limiting and finite, it somehow seems to me that the various accident probabilities are sufficiently low that Phase I of nuclear energy—at least as far as the United States is concerned—could very well pass without anything very serious happening.

On the other hand, [Enrico] Fermi, [Eugene] Wigner, and others who were in the nuclear energy business at the very beginning always thought that Phase II was the real name of nuclear energy. It is no coincidence that the first electricity generated by nuclear energy was from a prototype of a breeder. All of us sensed that Phase I was transitory and that the whole thing would finally hinge on Phase II, which might last forever. It is my own feeling that the social, institutional, and safety considerations that are acceptable for

something that is of limited extent may not be fully acceptable in the full flowering of an energy system that would last possibly as long as man uses any energy.

It was on this account that I felt that we would have to examine what we were doing in a more thorough way than we had in the past. And beyond that, it did seem to me that perhaps here was a key to coming to some resolution or some accommodation between those engaged in the present debate who like nuclear energy and those who dislike it. The argument is as follows: If one conceded that Phase I is self-limiting, some of the concerns about nuclear energy would also be self-limiting. Therefore, one would perhaps be prepared to live more easily with some of those concerns than if that phase were not self-limiting. These concerns, which seem small and irrelevant to some, become much larger if we consider nuclear energy as lasting more or less forever. It also seemed to me that there might be some way of looking at the matter that could serve as a bridge between the two sides of the argument. Appendix A outlines what we think the workshop will try to do. In this opening session, we will discuss general issues.

In the workshop outline I also specified five points that underlay my thinking about the matter. First, there is the question of the immensely long time that Phase II of nuclear energy could involve and, therefore, the weight of thought, innovation, and imagination I think is required to shape the immensely long journey we may be embarking on.

Second is a belief I have that nuclear energy really is something special. I do not think that this belief is shared by everyone in this audience. However, I do not have to remind anyone that, whether we like it or not, people somehow are not aware that radiation is routinely in the environment. To them it is, as I sometimes say, *spooky,* regardless of what we who have dealt with radiation believe.

I guess I would go back to a statement I will never forget that Enrico Fermi made. We were at one of the monthly information meetings of the Metallurgical Laboratory [in Chicago]. Fermi was sitting in the front row, along with the other giants of the Metallurgical

Project, and he waxed philosophical as he sometimes would. I will never forget his statement: "Remember that we are making a quantum jump in human experience. For the first time we are dealing with radioactivity on an immensely larger scale than we have ever experienced before." I do not think that any of us can forget the fact that a 1000-megawatt electric pressurized water reactor has in it 15 billion curies. This fact cannot be far from any of our considerations.

Third is the point of whether or not it is idle to speculate on the elements of a long-range future. I have already covered that. Some have suggested that it is idle. This is something that we will come to during the course of the discussions.

The fourth point consists of two rather specific views that I personally hold, but I have no brief that these are really essential. First, I think that high-level radioactive operations over the long run, and even over the short run, will have to be confined to as small a number of areas as possible. The question then is: How small is small and what is an acceptably small number of areas?

The next point is one that, I fear, has created a great deal of misunderstanding. It is my own belief that somehow one needs continuity and one needs dedication; and I visualize this as demanding people of very special expertise and commitment—a "cadre," I call it. In my first attempts of thinking about it, I mistakenly identified this as a government cadre. But if you read that paper [note 2, Appendix A] carefully, I also say that I am not sure that it has to be a government cadre. I think that point evoked more violent reaction than everything else that I said. Had I not said that, people would probably have gone to sleep on the matter. So it has served its purpose.

I was in Holland two weeks ago [1976] and made a point of talking to people about the dike system. I was struck with the fact that the dike system on which the integrity of the lowlands depends is somehow manned by a cadre that has long tradition. And, indeed, the best hydrologists in the world are in Holland. Their universities are oriented this way. I was told that the jobs of caring for the dikes and keeping them in repair tend to be hereditary. And the dikes have been going for

a thousand years. So as I think about the technologies that may have the closest analogy to Phase II of the nuclear enterprise, I think about the dike system of Holland.

Finally, I come to a point that is perhaps the most controversial: The present structure of the utility industry may not be quite the right structure for an enterprise that has the characteristics of the nuclear energy enterprise over the long run. Some of the entities may be too small. Perhaps this leads to a merging of the generating entities into something that conceivably might be a government entity or, much more likely, might be a set of nongovernmental entities.

The last point I would like to make is that the purpose of this workshop, as I have said, is to give us leads for continuing the study that we are planning and that we have contracted for with ERDA. We may decide as a result of this preliminary workshop that workshops of this sort ought to develop into some kind of continuing dialogue. That is one of the things we will try to decide between now and tomorrow afternoon.

Commentary

Dean E. Abrahamson, University of Minnesota

I hope that we do not try to arrive at any consensus at this meeting or at a set of recommendations in any report of the conference.

A central issue, not only in the nuclear debate but in the discussions of energy policy, is the question of demand; the ideology that goes into it could not be productively discussed here, however. Rather, we should assume that nuclear energy might be a viable option regardless of what our individual or corporate viewpoints about demand might be.

About six years ago there was a meeting not unlike this at Airlie House, Virginia; it involved several of the commissioners of the AEC [Atomic Energy Commission] along with staff members and a number of skeptics. In large part, it was not productive because of the position of AEC personnel on the proper role of the citizen as a client. Their definition of the professional/

client relationship included in the role of client everyone not directly involved in the nuclear enterprise, and a client by their definition was dependent and passive. To a lesser extent it was not productive because it was a private meeting; discussing the public's business in private is never a very satisfactory activity.

With reference to issues, it is clear that the ideals of social equity are not now being met with regard to the distribution of energy resources as well as other resources in the world. These ideals have not been given much weight in the determination of energy policy.

The disturbances implied by large releases of carbon dioxide are very troublesome. In 1973, there was very little awareness that the carbon dioxide problem would probably be the dominant one in considering the long-term viability of the solid hydrocarbons; and it still has not really entered into the discussion as it should, although that cannot be on our agenda here.

Turning to nuclear energy, I agree with Dr. Weinberg that if certain things had been taken seriously 30 years ago, or even 10 years ago, the situation now could be quite different. During the last 10 years we have seen a series of events that has put this industry in a rather chaotic position. I wonder how many people recognize that nuclear energy is indeed "special." In 1968, the utility executive who had just ordered two nuclear plants stated that nuclear energy just uses another kind of boiler. I believe this was a rather sad commentary on the awareness of the industry at the time.

The hazards are quite well known and were dragged into the public arena one by one over the kicking and screaming of the agencies' staffs. And when responsible agencies—and I use that in the legal sense—both public and private, are not being held in very high esteem because of past events, this industry is in political difficulty much more than it is in technical difficulty.

It is perfectly appropriate that the atomic industry and its various components get together and develop a credible proposal as to what they regard as acceptable for the long-term viability of this activity and that they advocate that posture in a vigorous way. I see this present meeting as part of that process. Not having done so in the past has contributed to the present chaotic situation. For example, when the environmental impact

statement on the LMFBR [Liquid Metal Fast Breeder Reactor] Program finally emerged after long and acrimonious litigation, we were all waiting to see how the safeguards and proliferation problems would be handled in the statement. It said that the present systems are not viable in the long run, although adequate for the present, and that adequate systems would be developed. If at that time a proposal had been made for what would be regarded as an adequate safeguard system, it would have simplified everybody's life.

I think the public interest has been served when there has been an informed political decision made with all private interests represented and with all costs and benefits, and the ledgers on which they appear, identified. And if we have an informed political discussion of matters that should be discussed in the political arena—as I think this one should be—then I will live with what comes out. To date, we have not had that informed political discussion on this question. And my own involvement has basically been to try to get issues introduced into the arena and to get people to participate in that arena.

I would end by commenting on the issue of taking a long-term view. We simply are not accustomed to dealing with things that require the long-term analyses necessitated by either widespread use of fossil fuels or widespread use of nuclear options. This may be the first time that political decisions have to be made when it is known in advance that there are very dangerous options and that some decision has to be made on the basis of a view that is temporally longer than we are accustomed to. The radioactivity problem must be viewed in a similar context. The notion that these pollutants are nonproductive enterprises and the choice of some optimal balance between control and releases have evolved from thinking of the more traditional pollutants; this has colored the management of the wastes associated with this industry. I think we simply have a category of waste on our hands that is not amenable to being handled in the traditional way.

W. Kenneth Davis, Bechtel Power Corporation

I come as a representative of the nuclear community and also as someone who has worked about 25 years in the nuclear business. I am still convinced that what I,

along with a lot of other people, have been doing is something that is worthwhile to the world and to mankind.

I really think there are some misconceptions about nuclear power. The first one is the idea that nuclear power has been developed with a total disregard for safety or safeguards and that these have been discovered only by some alert outsiders in the past several years. The second misconception is that nuclear power as an ndustry is something to talk about as a possibility for he future and that it really does not exist today. The third misconception is that nuclear power is not economic and not viable. The fourth misconception is that there are alternatives that are available now, that there is plenty of time, and that the economics are such that usage of nuclear power can be avoided by relying on solar energy, fusion, burning more coal, using oil and gas, importing oil from overseas, or through conservation. The fifth point was implied in earlier comments: The breeder reactor is a wholly new and different system, and it raises wholly new problems and, therefore, should be regarded as a vastly different kind of nuclear system.

I would like to talk briefly about each of these misconceptions. First of all, from the earliest days nuclear power researchers have been concerned with safety and safeguards and with the protection of employees and the public. In fact, most of the work that has been done over the years has been to try to develop a system that accommodates the fact that nuclear power is potentially hazardous.

In the list of issues, I notice that one of the statements from my letter was picked up, but was interpreted to mean "business as usual."[3] That is not the implication. The implication is that we have a system that can continue to evolve to meet the requirements as they are recognized and as they are needed.

The second point that is not understood is that we

[3]See the third item in Appendix B, Key Issues. The original comment from Davis' letter reads as follows: "There is no demonstrated basis whatever for a presumption that nuclear power and its related activities are hazardous to the public or the employees of nuclear installations or that such activities lead to 'safeguards' hazards under the controls being utilized."

indeed have a nuclear industry today. Over 10 percent of our electric energy today is being produced by nuclear plants (with the cold weather in the East, it may be running at something in excess of 10 percent). The total investment to date is probably around $75 billion, and additional commitments to date are probably in excess of $100 billion, even without any more orders being entered. I do not have good figures on employment in the nuclear industry, but I think it is in excess of 200,000, and probably closer to 300,000 people if we include construction and manufacturing workers. We have an industry that has the capability of producing nuclear power plants at a rate considerably in excess of that which is now being utilized.

Another issue that continues to come up is the question of the economics of nuclear power and how it compares with other energy sources in terms of reliability. The fact of the matter is that in most areas (although not all) of the United States, nuclear power is as economically advantageous on a cost basis as any other means of power generation. As far as the reasonably acceptable alternatives, Alvin Weinberg has commented on that. The important element is that, even if we assume a technology that we could apply on a large scale to help alleviate the energy problem, we are talking about a 25-year lead time between the completion of the development and its actual implementation on a large scale.

It is true that conservation can make very significant inroads on the demand for energy; it is also true, however, that our demand for energy will continue to increase and that U.S. resources are continuing to decline. So we have a growing gap between supply and demand with the demand being ameliorated somewhat by conservation. We also seem to have a growing demand for electrical energy at an estimated decreased rate of about 5.5 percent. Therefore, I do not think alternatives are available.

The last point is whether or not the breeder is a wholly new concept with new problems. I would visualize a transition, not a discontinuity. There is more plutonium involved, but not orders of magnitude more. And it will take about 25 years, once it is started, before there is large-scale implementation. There is no way to make the transition quickly.

So I am defending the system we now have; with appropriate thoughts and actions, it can handle an evolving system of power generation. I do not think that we really have any logical alternative, and I simply do not buy the idea that the nuclear power system has to be taken over and run by the government. In fact, I do not think that this would solve the problems that have been raised. I also believe that the present siting policy ought to be adopted for breeders.

Discussion

Each participant was asked to make a brief statement if he so wished.

Floyd L. Culler, Oak Ridge National Laboratory

Siting breeders in a more controlled manner is probably desirable. The fuel cycle, particularly the back end, should be considered as a separate siting problem and should be undertaken under controlled conditions. There are three principal reasons. One is the overall control of the radioactive effluents and the necessity for closely coupling reprocessing, fabrication, and, conceivably, waste disposal. Second, there is the broad question of diversion and safeguards. Third is the question of proliferation, which I would separate from the problems of diversion.

Some elements of the fuel cycle are possibly going in the direction of government management and tighter control; this is a reasonably wise move to the extent that these can be separated from the generation of electricity by reactors.

P. W. Howe, Carolina Power and Light Company

Nuclear energy is essential for a continued and reliable energy source in this country. Many of our problems in the nuclear community today are more social and political than they are technical. One of our critical problems is to establish a higher level of public confidence and credibility; a key element in doing this is to move forward and to resolve the issues of waste disposal and reprocessing.

I consider the breeder an extension of existing technology. We are not necessarily entering a new frontier here, but rather we are building on experience, and it is not clear whether a 50-year system and a 1000-year system require differences in depth of examination.

Irving Spiewak, Oak Ridge National Laboratory

We proponents [of a nuclear energy system] do not really have a good understanding of what the public concerns are or which public concerns will not fade away. These do need to be addressed by some political process that does not seem to have been devised yet.

The present nuclear enterprise differs from what it will have to be since it does not have an associated fuel cycle; but the breeder, which we need to work towards, will have a fuel cycle. There may be some intermediate stage at which we will have basically the present industry with a working fuel cycle after which we will reach something Alvin Weinberg might characterize as Phase II. We should work toward a system of public review of energy that would permit the options for Phase II to remain open. We need to focus on the process by which we will get from a viable, light water reactor, electricity-generating industry to a viable, long-term, nuclear industry, including a fuel cycle.

A. David Rossin, Commonwealth Edison Company

Although there are differences between the breeder and today's reactors, there are many features that are the same. [Institutional] structures that can function as they are today will function with some evolution and modification; there will not be an abrupt demarcation from one era to the other. The current generation of reactors has every bit of the broad, long-term implication that the breeder has. We will have light water reactors in the long run because not every reactor will be a breeder—even in a breeder economy.

One of the other issues is the question of public debate. It is time that we try to apply the same rules to all of the participants. It is time that everyone who makes an effort to be a spokesman subscribes to the [same set of] rules and plays by those rules. We cannot afford to have a double standard that says those on one side of the debate must be clobbered for not exhibiting candor when, in fact, they have their information on the line, auditable, and visible and those on the other side are not bound by any kind of ground rules. This is particularly important because of its function in the decisionmaking process. Those of us who have more experience began our roles in an era when leadership was a key element of the decisionmaking process. This was farsighted leadership anticipating the way things were going to evolve in the future; there was a sense of

long-range challenges and the recognition that there had to be long-range planning but that we could not do everything all at once.

Our decisionmaking process has changed substantially. A key part of the present process is the all-inclusive aspect—the need for all the answers for all time to come, the need for them right now, and the need to have all questions settled before any early steps are taken; and, if these needs are not fulfilled, we can take no early steps, which makes it impossible to complete the process. In order to get this set of steps agreed to, we must have a political consensus on that particular issue. This means that a tremendous amount of public involvement must occur. But this is a public that has its mind on things other than energy problems, and asking it to make, somehow, a political decision on this question is a unique situation.

Chester L. Cooper, Institute for Energy Analysis

All of us would probably agree on two things. First, over the next few decades nuclear energy may be the only way that we can get from what all of us would admit is a very uncertain "here" to what I suspect we all think is a kind of desirable "there." Second, the reliability of nuclear energy to get us "there" is questionable.

Now, if these two propositions are true, the task that we and some of our colleagues have before us is to make nuclear energy more reliable so that the public will have a greater sense of confidence. The resolution of this dilemma is one of the key challenges that the Carter administration will face.

We cannot define *long-term* as the time remaining between now and the next election; the issues we are discussing have very long lead times, by which I mean the lifetime of my grandchildren. That is a meaningful period of time to me; they will have to worry about their own grandchildren.

Although we will not be able to solve the problems here, we should regard this as the opening of a dialogue. If we start with this possibility, then we can hope that a group such as this can continue to move along this very difficult and complex path of trying to grope for a way out of this dilemma. I hope that our plans and objectives for the next couple of days will be to lay out the problem and understand where our perceptions may differ. If we disagree, perhaps we can reach a sense of

why we disagree and what the terms of the disagreement are.

Roger W. A. LeGassie, Energy Research and Development Administration

My present view of the analytical phase of this problem is that it is not possible to prove analytically in any real and satisfying sense either side of the problem. Namely, it is not possible to prove that nuclear energy is either desirable or necessary, nor is it possible to prove that it is undesirable or unnecessary. In whatever direction we proceed, there is a large risk that it will be the wrong direction and that it could produce downstream difficulties. This is true on either side of the problem.

Much of the debate is being conducted through legal rather than analytical processes. There is general agreement that legal processes are not necessarily the best way to improve an understanding of the problem—although they might be necessary for getting regulatory or social decisions.

I am sufficiently persuaded that there is enough similarity between present light water reactor systems and future breeder systems that, whatever the issues inherent in a long-term nuclear future may be, they are already present in seed form in the existing system. I prefer to put my focus and thinking on this phase of the problem rather than on something 50 years away on the theory that generic answers applicable to Phase I will be applicable to Phase II. It is not just a matter of enhancing confidence or of providing information in order to get a social judgment. It is a matter of actually changing the performance of two key institutions—the government and the utility industry—and the activities for which each is responsible.

The need is not as much for an ultimate answer as it is for an indication of the direction in which we ought not move; we need some performance specifications and attributes of the system. Getting a process going that will grapple with these issues after this meeting is really the critical question. There is a problem, as with any decisionmaking process, when one cannot even have a reasonably accurate statement of issues to which those with differing points of view could agree.

Finally, one does need to think in terms of modifying the performance of some of the existing institutions in Phase I.

Philip Sporn,
Private Consultant

As a nation, we will not be able to continue anything like the present without multiplying our total energy use twofold. This means roughly that we will have to move from 75 quadrillion Btu (quads) to 150 quads by the year 2000. With respect to the electricity component, in my judgment, the best that ought to be aimed for is to quadruple supplies between now and the year 2000. That means an average growth of 5.6 percent and is almost the official rate of the Edison Electric Institute. It is impossible to carry this out in the face of our declining oil and gas supplies without bringing in coal and nuclear energy to a much greater extent.

Nuclear energy is a growing concern now; roughly 10 percent of the electric energy in 1977 will be nuclear. Except for some kind of government order that the courts would sustain, it will be impossible to do anything to nuclear energy growth to make it less than roughly 25 percent to 30 percent of our electric energy component in 2000; it may be as high as 40 percent.

Nuclear energy is misunderstood not only by the general population, but even by technologists. We have had seven elections relating to the nuclear issue. In all of them the people voted, roughly by a vote of two to one, not to close down the nuclear energy program. But this has been misinterpreted as meaning that people have given the green light to nuclear energy development. They have not done so because it is very difficult for anyone to do who was as old as 10 in 1945 and is still alive.

Therefore, nuclear energy will have trouble growing to the 40-percent figure I mentioned. There is more delay now than ever before, and it will increase. You may have noticed that difficulties are increasing in Europe, especially in Germany, Switzerland, and France. It started there much later than here, but there is a feedback relationship between the two.

Our problem, then, is how to continue to have nuclear energy, not at the rate we originally thought, but at a much more moderate rate, amid some of the fears we have been talking about. We need to bring along a totally different relationship between the energy sector and the environmental movement. It is not an either-or situation; our society cannot be put in the position of making that choice.

Shearon Harris, Carolina Power and Light Company

We are really grappling with social and political problems as well as technical problems, and I want to touch upon just three or four areas. First, we must recognize that a substantial use of the nuclear option is essential for the kind of economy that political realities tell us we will have. We have not yet learned how to break the lockstep between a unit of GNP and a unit of energy consumption. It must also be recognized in public discussions that an adequate energy supply—which requires substantial reliance upon nuclear—is essential to our maintaining defense capabilities in the world.

Whatever rational planning we do, the forces of challenge will continue to impact upon rational planning to point out the dangers of the path of least resistance. On both sides, I think the keynote is a sense of genuine social responsibility.

Proliferation and safeguards are valid international issues and must be resolved in the international forum. The domestic use of nuclear energy cannot wait for this. I also submit that the resolution of the waste disposal problem is not the sole burden of the commercial nuclear energy sector.

George E. Brown, U.S. House of Representatives, California

I have not seen any significant discussion of the problems of plant decommissioning. More importantly, I want to note that the atmosphere in which policy decisions in the nuclear field will be made is changing far more rapidly than we might think. This was brought home to me last week when the Democratic caucus of the House struck down the Joint Committee on Atomic Energy. There is a ferment that is reflecting itself in the elected representatives and portends a vast broadening of dialogue on nuclear policy. In the House of Representatives, it means that instead of nine representatives on the joint committee, about 200 will be involved in nuclear policy issues, and they will be highly motivated to get people involved. This implies that the public, as well as elected officials, will be needing information previously of interest to only a few.

We need to be aware that the policy considerations in the nuclear debate go far beyond questions of energy or technology. There is a lot of discussion on proliferation. The change of attitude in the House of Representatives was probably triggered by the proliferation debate of the last year or two.

There are philosophical problems of considerable depth involved in the changing policy environment; there is a neo-Luddite atmosphere that almost rejects the industrial revolution and wants to go back to a more pastoral type of life. Therefore, in discussing nuclear futures, it behooves us to imbed that discussion in the broader framework of policy that we are trying to make for 10 to 20 years in advance and that will impact on us 1000 years from now.

Thomas B. Cochran, Natural Resources Defense Council

The view that nuclear energy is necessary to meet energy needs is not shared by all of the people in the debate. A lot of the people who have spoken out against nuclear energy are simply not in a political position at the moment where they can really talk about a compromise on some sort of acceptable nuclear future because there is a serious risk that the acceptable nuclear future will never come about. Any move they make towards suggesting there is even a reasonable chance that this could be effected would be an impetus towards nuclear growth along the "business as usual" line. If one is looking for compromises, the initiatives will have to come from the pronuclear side and will have to be more along the lines of agreeing that there will be no commitment at all at this time to Phase II and to the plutonium economy with all of its safeguards and proliferation aspects. The option of shutting down the program as well as the possibility of continuing it should be left open.

I am not offering a compromise, however; the antinuclear people are not in a position politically where they would even be willing to talk about such a compromise because just simply talking about a compromise in that regard would be interpreted as an acceptance of an expansion of Phase I. And this could, in fact, be counterproductive to their goals if Phase I were suddenly expanded to the extent that Phase II became inevitable.

Any compromise should come from the industry. At a minimum, they should take the position that they will not commit themselves to Phase II and should show they can operate in Phase I in a manner that is more acceptable to the public in terms of reactor safety and in terms of waste disposal.

H. G. MacPherson, Institute for Energy Analysis

A dozen years ago the nuclear utilities, in their fragmented form, had committed themselves to some 55 very large nuclear reactors of the light water reactor type when the largest operable reactor was 180 megawatts-electric. I thought at the time that this would not have happened in an integrated industry; the pace would have been a little bit slower and the commitment of the many billions of dollars would have taken longer.

Clearly there was an enthusiastic embrace of the present light water reactor program. This is different from the approach that will get us into the breeder program. The situation with the breeder reactor is different in two respects. All of the people I know believe that the first one-half dozen large LMFBRs will be non-economic and there will be large costs to be absorbed by somebody else—either by a coalition of utilities or by the federal government. Therefore, the breeder economy will involve the possibility of some changes in organizational setups that may not be radical but will require organizations that do not exist now.

Sidney Siegel, Private Consultant

I am convinced that nuclear power must be available to the nation. It may be at a level as large as Phil Sporn's scenario or at a lower level, but I know we will want to do so in an acceptable way.

We initially oversimplified the deployment of nuclear power; we enthusiastically developed the reactor and advocated the notion that all one had to do was replace the boiler with a nuclear reactor and the utility could proceed, more or less, as it had in the past.

I want to dwell on two points Ken Davis brought up. One is that we already have a nuclear industry today—I rather doubt that. We have firms building reactors and we have utilities using them effectively. But we all recognize that a number of other components are in bad shape: We do not know how much uranium we have, we have difficulty deciding how to produce enough separative work to supply the reactors, and the reprocessing situation is very unsatisfactorily handled at the present time and is ridiculously interrelated with the irrelevant issue of proliferation. Also, we do not have waste disposal in good shape. So it is hard for me to accept the notion that we have a viable nuclear industry; only a few elements of it are in satisfactory shape. The second point is that if we are to depend upon an evolutionary

approach, it had better be a far more critically directed evolution—between now and the year 2000. What is needed to develop the nuclear enterprise does not exist as it did for the conventional electric utility industry. The evolutionary approach worked for the latter because when Edison invented the electric lamp and the industry began to expand, there was an existing coal industry and a transportation system as well as numerous industrial and institutional arrangements from which the electric industry naturally evolved. These elements that the nuclear system also needs seem to be missing. The only way we can arrive at an acceptable enterprise is through purposeful effort to integrate the entire system.

John D. Selby, Consumers Power Company

The cost and availability of energy is a much broader problem than just that particular question itself and is very directly coupled with the future political system of this society.

As one responsible for delivering kilowatt-hours, I would be willing to consider any proven system that gives some hint of economic viability and reliability. In that sense, I am clearly a supporter of nuclear energy because I do not really see where we can go otherwise.

Directly coupling the problem of waste control and nuclear energy is wrong. This society and future generations are committed to solving the nuclear waste control problem whether or not we generate another kilowatt of electricity from nuclear energy. Approximately 90 percent of the total waste that we will have to handle by the year 2000, if we go ahead with the present light water reactor plants, will be that from various military programs. Our judgments should be to the effect of the added increment as opposed to whether or not the problem can be avoided. The same is true of proliferation.

With regard to the long-term question, I will put it in the context of differences between the breeder and the burner reactors. None of the major problems of social acceptability of the burner reactors will be solved by the breeder. The only problems that may be solved are the ones of economics and fuel availability.

It does make sense to look at the long-term situation, but it must be considered in the broad context of the political and economic effects on our society. We should not give up the private enterprise system in order to control electricity generation using breeders.

There will be changes in breeder implementation, as compared with burners, if for no other reason than the financial aspects. I am not at all sure that the utilities that can afford to install a burner reactor today could possibly approach the breeder situation. Regionalization of ownership, as Mr. Sporn has suggested, will probably be forced for that, if no other, reason.

Joseph C. Swidler, Leva, Hawes, Symington, Martin, and Oppenheimer

In listening to the nuclear versus antinuclear debate, three questions tend to surface. First is the extent of the need and the urgency for additional energy supply. If we had a better opinion for the need of energy in the future of this country—say in the next 25 years—this would tend to clarify the nuclear debate.

Second, solar energy is frequently offered as a way to avoid the dilemma between coal and nuclear energy. If we can have a better perspective on the time factor involved for this technology to achieve practicality, it would tend to limit the debate.

The third is the extent to which we can reasonably expect conservation to hold down the demand. If we could get some agreement on the extent to which conservation can succeed, it would become easier to look at the question of how far we need to go with nuclear.

With respect to the terms of the debate, an initiative referendum is not, except in the West, a common way of settling issues. In most of the country, we assume that difficult questions are settled on a representative basis and that the town meeting is not the right forum. Therefore, we need to look at whether the referendum is the right way of settling nuclear questions, and, if it is, then we need to look at the question of how we get a referendum that could settle something. I am not sure that we could ever get a referendum that both sides agreed met every test of fairness, and we need to do some thinking about what constitutes fairness of presentation. An objective evaluation of the following would be very useful: What is the balance of information now? Is one side or the other right in saying that the news is loaded? And if yes, how can this be corrected?

Joel Stronberg, Energy Research and Development Administration

As basically a layman, I am willing to take the leap of faith and rely upon our technicians and scientists who state that nuclear energy is a practical solution to a very pressing problem. I am concerned about several

factors, however. One of them is that once those of us who are trying to determine policy and communicate with people enter the public arena, there are certain things that we owe. We owe fair communication and translation of some very technical jargon into a language that must be understandable to people if we are to ask them to help us make the decision. We owe accountability, and we must be careful to be objective and not put forth our own individual and special interests.

We cannot ignore the fact that the energy problem is an international problem. And we must recognize that there will be a need for trade-offs and that we do have an energy crisis. We must recognize that the environment may suffer to a certain extent, but that there are ways of minimizing the environmental costs. We must recognize that while a complete degradation is not necessary, we probably cannot maintain a pure, pristine environment—not if we are to answer the energy questions.

Louis Centofanti, Carter-Mondale Transition Planning Group

My interests and my background are such that I have not taken part in the debates on either side. I am interested in energy in general and am very familiar with the nuclear problems and can see points on both sides.

What bothers me very much about the events in the nuclear area is that I see the initiative, as has already been mentioned, not as a green light but as the opening battle in a war, and at this point I see neither side coming out the victor. What we will probably end up with is the worst possibility—a stalemate where everybody is constantly fighting. Both sides have to reach a consensus; and it has to involve the public.

However, the overall problem may just be too large for agreement, and a good starting point would be to focus on one of the subareas, such as waste disposal, which has to be solved no matter what happens. Perhaps the next meeting might focus more on that and expand the number of the participants to include a broader range of views and interests.

Robert McCracken, General Electric Company

My first concern is the ground rules for this debate. When my colleague, Tom Lee,[4] was here two months ago, he said that if people who favor nuclear are the

[4]Thomas H. Lee is manager of the Strategic Planning Operation for GE's Power Generation Group.

football players and the people who do not favor nuclear are the basketball players, the political arena is the tennis court. So it is not too hard to understand why we do not get anywhere when we are each trying to talk about our own particular area of interest.

I agree with Ken Davis that the nuclear energy industry infrastructure exists; I do not agree that it is viable. The reactor manufacturers will not show a cumulative profit at the end of this year. There is no such thing as a standardized plant.

And when we look at how fast we have pushed the technology of light water reactors, it is not hard to understand why we have that problem. In one 10-year period, the size of nuclear power plants went from 265 megawatts-electric to 1090 megawatts-electric; and when that 1090-megawatts-electric plant was ordered, we did not have experience on a plant larger than 265 megawatts-electric. Therefore, we need to take a hard look at the lesson of pushing the technology.

In the short-term, we can do a lot to solve the problems by paying attention to improving the performance of existing operating plants and by beginning to take a much harder look at standardization and slowing down the technology race.

For the long-term, there probably will need to be a lot of changes. Suffice it to say that the industry (especially General Electric) is very anxious to participate in the debate on what those changes ought to be, if any. We do believe that nuclear energy is vital to this country in terms of getting us from here to there, and that it is practical, economic, and environmentally acceptable.

Colin Heath, Energy Research and Development Administration

It is obvious from the very nature of the role of the ERDA assistant administrator for nuclear energy that our position must be in favor of an acceptable nuclear energy system in the future. Part of our charter is to work on that. I would like to emphasize that the recent Presidential statement focusing on proliferation shows that we recognize the legitimate concerns.

I agree with Roger LeGassie about the connection between the breeder and the light water reactor, but I think the reasons are social and economic rather than technical. Technically, one could certainly go to a breeder; but the economic impact is very significant,

particularly in terms of private investment.

I would like to hear from the participants whether anybody really feels that energy generation should not be part of the private sector. That is the key to a lot of further decisions to be made. If this country—society—makes a decision that energy generation remain in the private sector, then one is led to conclusions about protection of existing investments and protection of the existing industry, and making [energy generation] viable.

I would be surprised if we were to get a consensus, but I am sure that it will be helpful for all of us to hear each other's views.

Manson Benedict, Massachusetts Institute of Technology

I do not think we need a very radical solution in order to make the breeder an acceptable member of industrial society. I would simply like to highlight a few conclusions I drew in assessing U.S. energy needs for the next 50 years and the suitability of our different national energy resources for meeting them.

Even with strict conservation, which certainly is necessary, the U.S. energy demand is bound to increase—probably nearly double—within the next 25 or 30 years. If not, we will have widespread poverty and social disorder in this country. And perhaps even more importantly, we will be unable to do our part in maintaining international security. An industrially strong United States is absolutely necessary to international stability. Therefore, the question is: Where will this increased energy come from? Because of the dwindling supplies of oil and gas, we will be lucky if we can maintain our present production rate of those materials. Coal will have to be used much more extensively, especially as the source of substitute hydrocarbons for oil and gas that we will not have.

Electricity demand is bound to increase, and primary electricity will have to provide a greater share of our energy input than it does at the present time. The major sources for the generation of electricity will have to be coal and nuclear despite the hope and the optimism about fusion, solar, and wind energy. The latter are bound to be minor rather than major sources of electricity in the 25-year time frame—and possibly forever. We do not have enough uranium to go much more than 25 years with light water reactors, and after that it has to be the breeder in one form or another.

Abrahamson

The example of the nuclear utility executive in 1968 was meant to give only an indication of the degree of understanding of the nature of nuclear energy at the time the utilities began making commitments.

I am not saying that I would consider due process satisfied only if there were a full referendum with full information and with fully informed individuals. What I did say is that the decision should be made in the full political arena—taking into account all private interests and clearly identifying the costs and benefits.

I view my role here as an observer. I really questio.. the appropriateness of even being here because this is, in many ways, a "council of elders" in the nuclear establishment to hammer out a common agreement as to what might be an acceptable nuclear economy.

If this industry is going to be represented by the position that nuclear energy is an absolute necessity for maintaining present growth rates and that there are no alternatives, then the burden of proof lies with those who are making these assertions.

Culler

It is important that we all realize that part of the group says that the issue is not really whether nuclear energy is acceptable, but whether we need as much energy as we say.

LeGassie

I have made a list of what I think are the most substantive questions that were asked:

Should the focus be on Phase I as opposed to Phase II?

Are the issues, in fact, understood and able to be articulated in a way that both parties could agree that these are indeed the issues?

Is a real change needed—as opposed to some window dressing treatment?

Can we rely on evolution, or must we do something more substantive?

Is nuclear special? And if it is, what does that imply?

Will the future energy system use the private sector in the same way that it is presently used?

Can you deal with this problem without dealing with it internationally?

Is the development of a process for addressing the question the real first step in making progress?

From the standpoint of tactics, would it make more sense to emphasize subissues and try to reach agreement on them, one at a time, as opposed to trying to deal with a set of issues?

How can we make what both sides might view as progress in this area considering the possibility that there is a lack of incentive for one side to participate since it is doing quite well without participating?

How do we get the nuclear industry, assuming that it is necessary, to demonstrate a greater sense of social responsibility?

Weinberg

The question of regionalization, which was raised by at least two of the speakers, should also be added to the list.

These statements have been very useful. Yet, I confess to a slight disappointment in the following respect: I remind you that the ground rule, which was somewhat arbitrarily imposed on the workshop, was not whether we need nuclear energy, but, conceding that nuclear energy is necessary, what can we as a society do to make it acceptable.

I want to make it clear that the objective of this workshop is not to come to any conclusions; we certainly are not asking anyone at the meeting, either as an observer or as a participant, to take such a responsibility. We are here to try to have a reasoned discussion on what is a rather narrower issue than the entire energy question.

Session II

Long-Range Issues

Statement

H. G. MacPherson

In this session we want to look at the characteristics of what might be a viable and an acceptable nuclear industry in the long term. For this purpose I selected the year 2050, since by that time the dominant reactor type—if there is a reactor industry—will be the breeder reactor, and we must consider the situation under those circumstances. Also, by then the nuclear industry will be many times larger than it is now. In fact, the whole electric power industry will be considerably larger.

In 2050 we may be approaching a state where the rate of increase in energy use is relatively gentle and within the capability of the breeding performance of the breeder reactors to supply the necessary fuel. Uranium mining will be nonexistent—or at least a minor activity—as will uranium isotope separation. The nuclear industry will consist of the power plants themselves, chemical processing plants, fuel fabrication plants, waste disposal, and related transportation activities.

It would be nice if we could just imagine that we were in the year 2050 and could see what the industry would be like then—and what characteristics we would like to see in that industry. However, in a sense that would be trivial. If there is a big industry in the year 2050, most of the problems that we are presently concerned with will have been solved. So we cannot really

divorce ourselves from the problem of how we get there from here.

Within this time frame I would like to present three sets of questions:

1. What desirable attributes would we like this nuclear energy system to have? What problems would we like to avoid?
2. What characteristics of the organizational institutional structure are desirable to meet these attributes and avoid the problems?
3. What specific organizational structures or regional patterns would be suitable? How do they fit the criteria? How do we get there from here?

What are some of the desirable attributes and what problems need to be considered?

1. We must remember that the major desirable attribute is that we are trying to generate electric energy, so the system we have should be efficient and should provide energy at as low a cost as is reasonable.
2. Do we wish to make use of the waste heat from the reactors? For example, do we wish to use it for house heating and cooling? This becomes a problem because it is in conflict with certain other objectives that one might want to have in terms of isolating or grouping the nuclear facilities.
3. There is a larger question that concerns us probably more today than any other. This is the question of radiological safety—safety from reactor accidents, safety in transporting materials, and safety in storing waste so that leakage from the waste does not result in any radiological hazard.
4. Another attribute is that we want to avoid the diversion of nuclear materials for weapons or terrorist activities. I would point out, though, that this is anomalous with respect to the time frame I am considering. It is easier to predict that prolif-

eration will have occurred by then and that it will have to have been dealt with somehow if we are to get there from here in a relatively safe manner.

There are also commercial aspects that have desirable attributes; it is nice to have a taxable industry. If there is a power-producing system, I would think that international trade in reactors and the related technology and international trade in fuel would be a subject to consider. I am not saying this is important, but it is one of the attributes that, when we start to think of the organizational structure, needs to be taken into consideration.

The question of how these characteristics are affected by the organizational structure and the efficiency of operation must also be considered. Most of us believe that private ownership and private operation generally lead to efficient operation. This is true in part because of the necessity for turning a profit and in part because it is nice to have an organization that has a period of adversity now and then so that it can trim excess fat. I am personally somewhat afraid of government ownership because of the bureaucracy and the inefficiencies that could creep into it.

A characteristic that one would like out of the organizational structure is the availability of technical expertise. I happen to place quite a bit of personal importance on this. It is one of the reasons I tend to favor large organizations in the power generation business—ones that have the technical capability and sophistication to understand the problems and to handle them when they arise.

Then there is the matter of financial responsibility, and this goes along with an ethical responsibility. We are all aware of the present difficulty of financing the more expensive power plants that are coming in. We are aware that Consolidated Edison missed a dividend and had to bail itself out by selling its nuclear plant to New York State. We are also aware that the West Valley [New York] processing facility gave up the ghost and left its refuse to New York State to handle. Thus, the ability to handle financial obligations is important. It should not be regarded as just a business venture, but

as one with public responsibility, in terms of both the long run and ethical responsibility. Thus, the organizational structure should have some means of providing continuity, and part of that is training and bringing in new people so they understand their responsibility with regard to the political, social, and technical aspects. A continuing, renewable corps of people with the sophistication to handle the business is necessary.

The question of dispersed plants versus energy centers and the problem of collocation must be addressed. In recent years more and more people have been talking about collocation of processing and fuel fabrication facilities as a desirable thing. The next step in the scheme that I propose is to have these facilities closely associated with the centers where the plutonium is being burned so that there would be a minimum of transport of fissile materials. That proposal, incidentally, is made only in the context of looking forward to a period when the worldwide nuclear industry is really tremendous and, if there were not some sort of control, just keeping track of where the fuel is would be very difficult.

The type of organization that might have these desirable attributes must also be considered. These range from the present, somewhat fragmented situation in which we have a large variety of utility sites ranging from the very large to the quite small with the operators of the latter getting together for some of their nuclear generating facilities. We need to consider the architectural/engineering firms that actually handle a great deal of the work in the construction of all of these plants, the Nuclear Regulatory Commission, the projected processing and fuel fabrication plants, and waste disposal. The NRC will never be a private industry. However, if the balance is completely on the side of the private sector, I can honestly say that the present fragmented situation will continue with uneven capability and an uneven sense of responsibility.

The extreme of this would be government ownership of the whole enterprise. I have strong reservations about this. Somewhere in between are the mixed government/private systems of the COMSAT type

[Communications Satellite Corporation] or the Pugeot-Renault enterprise in France. Other countries have mixtures of private and government-owned enterprises that are run pretty much on the private enterprise pattern and operate in a fairly efficient manner. [Our] government will probably have to be involved because it is hard to see at the present time how private industry can manage the breeder without large injections of funds. Presumably, the utilities that sell electric power could allow themselves to be taxed enough to provide a pool of funds. The other possibility is that the federal government will supply the money.

I have some friends in private industry who would like to tell the government the following: "Please send money, but do not send your advice." But that has very seldom happened. Usually when the government supplies money, it also wants to have a fair amount of supervision over that money. For example, ERDA has taken the lead in the Clinch River Breeder Reactor organization because the government is funding about 80 percent of the construction.

I do not believe that it will be possible to launch the breeder reactor industry without having the government involved to some degree. I would like to propose some mixture that has a heavy involvement of utility organizations with one component of this mixed organization representing the customers to be served by the plants involved.

I picture a generating company that is separate from the utilities, which distribute the electricity and have a very strong management and financial interest but not complete control. I believe that the federal interests (i.e., funds) will be so strong that the government will have to have a strong position on any board of directors, pointed at representing the public. This is especially true in the development end. For example, in breeder development the numbers are something like $12 to $13 billion. And this does not include the subsidies required to get the first half-dozen plants over the hump into being economic nor the provision for the fuel cycle, which is probably another $2 billion. Therefore, I think the government's stake in this will be large.

Discussion

Selby

The breeder will need government money for development. However, if it does not become an economically viable operation for the commercial industry, then the program will have failed.

The fact that government takes the risk on these high capital development programs is not unusual. This country has developed a number of industries out of government monies. For example, the commercial jet aircraft industry was developed with government money; so was the aircraft control system based on radar. Fundamentally, the objective has to be economic and commercial viability, or we ought to drop the development.

Sporn

If there is not going to be a nationally viable nuclear industry from breeders, why do we not drop everything we are doing on breeders? The presumption is that we think it will be commercially self-supporting. Surely, it is in the best interests of the country for the nuclear industry to be in private hands—unless we change our entire sociopolitical organization.

Weinberg

This is a pretty fundamental point, and there are different ways of achieving the same ends. Regarding some of the ends Dr. MacPherson spoke of, there are no arguments. Ultimately, it has to be an economical proposition. With respect to some other ends, there may be questions. One is the issue of whether nuclear energy is so special that we require a particular degree of continuity that we cannot guarantee in a private enterprise. If we concede this, then I would say that is a valid reason for thinking of something other than an ordinary private enterprise.

LeGassie

I would phrase the question: What are the characteristics of a future system? in terms of the missing characteristics of the present system.

First, I would list the regulatory processes. I personally believe that there ought to be concern about

the environment, safety, antitrust, and those things that the government regulates. The nature of the regulatory process is that somebody hears the cases or the arguments and is appointed to make a determination that is presumably fair. I believe it is clear to everyone that the present operation of the regulatory process is highly deficient in the sense that it does not provide answers on a timely basis.

The second item I list has been mentioned already; his is the matter of standardization. We continually refer to things such as the aircraft industry where safety is a predominant concern. We have classes of planes that get approved as classes, and we manufacture them to a given set of specifications. Why should there not be expeditious action to standardize existing light water nuclear power plants and standardize those of 2050—whatever they turn out to be? That is a missing key characteristic of the present system and one that certainly ought to be in place in future systems.

The third point relates to the procedures and technology for the management of wastes. While it is nice to say that the civilian nuclear waste problem is only incremental to the defense wastes, I am not sure this is a fully persuasive argument. Everyone would like to believe that he had in view what the process was and had some confidence in it.

My fourth item really represents a series of things that are in the fuel cycle: There is a need for a functioning uranium supply market and a functioning enrichment market, if one is in the light water reactor business. There is also a need to settle the posture for some period of time on reprocessing. Perhaps 90 percent of the step has been taken in that direction, but not everybody has bought it.

There is a need to establish what the international arrangements are to be for technology control and for the supply of fuel cycle needs to countries that do not wish to perform these services themselves because of proliferation concerns.

There may be a need to move promptly on the question of redesigning reactor cycles if, in fact, we are

not going to have reprocessing for a lengthy period of time. It seems to me there are questions about modifying the way and the degree that responsibility is taken by the utility owners and operators of plants in terms of how they procure, oversee construction, and meet the various aspects of social responsibility that go with the operation of these plants. This would include questions such as whether or not the category of being a reactor operator ought to become equivalent to that of being a doctor or a lawyer or an engineer or an airline pilot.

Commentary

Manson Benedict

The most useful thing that I could deal with this afternoon would be to give my reasons for feeling that many of the concerns expressed about the breeders can be adequately dealt with within existing technology. I am addressing myself to the breeder because despite all of the objections that are being raised to the light water reactor industry, it is making its own way. Given a fair chance, it will provide a useful supplement to other energy sources in this and in foreign countries for the next 25 or 30 years.

So even though some people here think that we ought to concern ourselves more with questions for that period [i.e., around 2000], it is valid to look beyond that time to when we—if we do not find more uranium resources—will definitely need something better than the light water reactor.

I will talk very briefly about five aspects of the breeder: economics, nuclear waste—which is not unique to the breeder, the possibility of nuclear accidents in the breeder reactor, plutonium toxicity, and plutonium diversion.

With respect to economics, I think we would all agree that if uranium resources are much more abundant than we presently know and if uranium from them can be produced at prices not much higher than at present, the very substantial sums that will have to be spent to

make the breeder commercial are not worth spending and we might as well put the whole project on the back burner.

The case for the breeder definitely depends upon there not being an order of magnitude more uranium than we now feel quite confident that we can find. I believe that the development of the breeder should progress in parallel to a very amplified effort to identify and quantify the extent of uranium in this country and elsewhere in the world and measure the economics of its production.

The other aspect of the economics question is that to some extent those who claim that the breeder is not economical have at their disposal the means to make this a self-fulfilling prophesy. The people who are really opposed to the breeder and think it a matter of great personal concern to them can lead to unnecessarily strict licensing requirements and protracted licensing delays that will so riddle the first project with uneconomical costs and the threat of bankruptcy that the project will not go ahead.

The proposal was made many years ago by a committee of the National Academy of Sciences that wastes be disposed of in geologically stable, nonviolated beds of rock salt. Technically, this is a perfectly satisfactory solution. The problem is that the first attempt to do it did not have adequate field work. The salt deposits examined did not meet the criteria and thus became a matter of political advantage to people who were opposed to it. It will be very difficult to get the social acceptance for using any deposit now that we have had this bad experience. I do hope that ERDA will make this a matter of the highest priority and will deal with it not just on the technical level but also on the social and political levels and get on with the job.

I might point out that wastes from the breeder are no worse than wastes from the light water reactors in terms of the amount of toxicity they contain. Having a breeder provides one possible option for getting rid of some of the longest-lived constituents of the waste, since the breeder is a much more efficient burner of the long-lived actinides than the light water reactor.

Next, I would move to the question of nuclear reactor accidents. The principal risk that most of us visualize for the breeder is not the loss of coolant accident. If properly designed and properly built, the sodium-cooled breeder reactor may be practically free of failure from a loss of coolant because the coolant is not under very high pressure and because sodium is an excellent heat transfer medium. Rather, the problem is the possibility of uncontrolled energy release from a supercritical accident. This would result from the very unlikely loss of coolant or from failure to scram the reactor through some very serious malfunction of the control system. There are a number of measures that, if taken together, could prevent, with acceptably low probability, the occurrence of this accident.

First, to ensure that there is a properly low probability of failure to scram the reactor, two independent and diverse scram systems are presently required. Even with that, there is some probability of failure to scram.

Second, I believe that the concept of the so-called built-in reactor fuse, which was investigated at Argonne National Laboratory some years ago, may be effective. This would be separate from the automated control systems that require external intervention and would automatically and inevitably provide for the insertion of control absorbers under gravity. The old Reactor Development Division of the Atomic Energy Commission squelched the desire of the Argonne National Laboratory to continue to explore this idea on the grounds that if one admitted needing anything of this kind it would cast doubt on the acceptability of the present systems.

Another measure that one can use to keep reactors from having uncontrolled accidents is to maintain a sufficient level of coolant in the reactor to prevent the meltdown of the fuel if there should be trouble.

The suggested use of a core with an internal blanket would greatly reduce the positive magnitude of the sodium void coefficient and possibly even turn it around and make it negative. That would greatly reduce the amount of uncontrolled energy release that might result from any sort of initial primary supercriticality.

Finally, and as a possible additional backup measure, the provision of a sufficiently strong primary reactor vessel to contain any energy release if all of the above failed would prevent any offsite consequences from nuclear accidents.

Any rational assessment of the safety of the fast reactor—assuming that we could put a reliable measure on the nonscram failure probability of the system—would find that the probability is 10^{-6} instead of the legislated 10^{-7}. This should then be combined with an assessment of what would happen if the reactor did not scram. If other backup measures (such as a very strong containment) exist, it seems unnecessary to me to require that an undue amount of money or trouble be spent to change the 10^{-6} to something lower.

It helps to be able to quantify these things, provided we recognize that the error band on our estimates is probably pretty large. In the end, there does have to be a social and political judgment as to whether we want to have an adequate supply of uninterruptable electricity and run the risk of having—perhaps every 100 years—a rather bad industrial accident. We ought to bear in mind that no human activity is absolutely safe, and we should accept some small risk from everything we do provided the product of that activity is something society badly needs.

The next issue I wanted to address is plutonium toxicity. This is not quite as bad as some of the opponents of nuclear energy have sought to make us believe, but it is a very toxic material and hangs around for a long time, although its half-life is not infinite, unlike some other industrial poisons. It should be handled with great care. Certainly anybody who has had plutonium spills and has had to clean them up would agree with me, even though the degree of decontamination required might have been unnecessarily great.

We ought to bear in mind that plutonium has been handled in very large quantities up to the present time and has been produced in very large amounts by the Atomic Energy Commission. It has been transported over long distances in this country and overseas. Many people have been in contact with it. And there have

been very few, if any, really authenticated instances of anybody's having been hurt. Some people handling plutonium have picked up more than the guidelines say is healthy, but there has not been evidence of a serious health problem. This is an unusually fine record for a very toxic and a very dangerous material when we compare it with the troubles we have seen with the products of other, less strictly regulated industries. Now that there is so much concern about it and so much regulatory overview, I think that it will be handled even more safely in the future. So I am inclined to dismiss that as one of the problems in going into this new era of energy production rather than seeing it as one of the reasons we should not go into it.

Finally, the plutonium diversion question. This has been highlighted recently by the very decisive studies that have been made by such people as Willrich and Taylor.[1] We do have to be concerned that plutonium produced in pure form at some point in the nuclear fuel cycle not get into the hands of either foreign governments that have no business having it or into the hands of subnationals who would like to use it for their own purposes. I do not think that this is a legitimate reason for banning the production of plutonium at an appropriate step in the nuclear fuel cycle. The problem arises when too much chemically pure plutonium in too many different places is out of the direct control of competent people.

There are several ways of dealing with the possible plutonium diversion problem from a fast reactor nuclear fuel cycle industry. One of the most important measures is the collocation at the same, well guarded site of the reprocessing plant that makes the pure plutonium and the fabrication plant that converts the plutonium from a nearly chemically pure form into a diluted form in a fairly massive fuel assembly. The fuel assembly could be shipped safely with guards over a well known route and with adequate oversight as to the location of the vehicle at all times, thus alleviating the risk that the material

[1]Mason Willrich and Theodore B. Taylor, **Nuclear Theft: Risks and Safeguards** (Cambridge, Massachusetts: Ballinger Publishing Co.) 1974.

would be a sufficiently attractive target for a diverter to hijack and go through the rather complicated process of getting the plutonium out of the fuel assemblies and into a form that could constitute a nuclear explosive.

I know there are people who feel that diversion is more likely than I think it is. If their view prevails, there are ways of making plutonium shipments from the reprocessing and fabrication plant to the reactor so secure that no group will try to divert the shipment. The fuel can be made radioactive after it has been fabricated so that it has to be shipped behind shielding. If anyone wants to do anything with it, he would have to have such elaborate facilities that I defy him to convert it to a bomb before we could get it back.

Discussion

Heath

If transportation is such a critical step in the process, then why transport at all? Why not have the reactors on the same site?

Benedict

It is a lot cheaper to transport the plutonium—even with these elaborate precautions—than it is to transport electricity over great distances.

Siegel

Plutonium does not necessarily have to be recycled through the conventional light water reactor. It could be recycled through specially designed plutonium burners so that only enriched uranium fuel is transported. Reprocessing, refabrication, and plutonium burners would be at the centers.

Benedict

I know that argument is given, but if one looks at the economics of reprocessing, it is a waste to reprocess fuel from a center with a capacity of 10,000 to 20,000 megawatts-electric. It is more economical to do it for a system with a capacity of 50,000 or 60,000 megawatts-electric, which means servicing reactors outside the center as well. And I do not see the desirability of doing something simply because people feel that transporting plutonium with adequate safeguards is not an acceptable risk. It is a perfectly reasonable risk.

Siegel

If there is a mix of light water reactors that burn enriched uranium and light water reactors that burn plutonium, that mix could be physically segregated—disperse the light water reactors that burn enriched uranium but concentrate the others.

Benedict

On Alvin Weinberg's time scale, we will not have any enriched uranium to fuel our reactors. They will either be fast reactors fueled with plutonium and depleted uranium or thorium or reactors burning the surplus plutonium from the breeder reactors.

Mason Willrich, The Rockefeller Foundation

I think the important point that Manson Benedict has made regards the collocation of fuel fabrication and chemical reprocessing facilities. And this goes back to what Roger LeGassie was saying earlier about the impossibility of government's making decisions.

LeGassie

It is worth noting that there was a study mandated by law and carried out by the NRC [Nuclear Regulatory Commission] regarding centers. At the conclusion of the study the Commission could have made a decision. The question was discussed in the Commission, and they decided not to take action on the study. There has been a failure of will in the system. There does seem to be one thing on which there is uniform agreement—the desirability of collocating reprocessing and fabrication facilities. Why is this then not established as a matter of policy?

Heath

Is it not true that the NRC perhaps does not want to make that decision because in so doing it would be accused of having preempted its decision on GESMO?[2]

Howe

If the argument for collocation is made on the basis that this reduces the chances of diverting plutonium, the fact that we have had substantial quantities around for a number of years is ignored. We have made

[2]**Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors,** Office of Nuclear Material Safety and Safeguards. U. S. Nuclear Regulatory Commission. August 1976. NUREG-0002, ES.

shipments from Savannah River to Rocky Flats, Los Alamos, and Hanford with no attempts that I know of to divert it.

If I were a terrorist, I would certainly go for some good, clean product rather than some messed-up, commercial grade plutonium. A weapon can be made out of commercial grade plutonium, but my point is that we are now being mesmerized with the proliferation and liversion issue.

And another point I would make is that we are no longer the sole possessor of the technology. Thus, for us to avoid reprocessing on the assumption that in this way we will avoid either diversion or proliferation is somewhat naive when a number of other countries possess this technology.

Commentary

Thomas B. Cochran

I will have to bend the ground rules a little bit to carry on from where I was this morning. I think the approach laid out here is flawed, and I would rather not play with the existing ground rules.

What I tried to lay out this morning was that there is a large spectrum of views, and a lot of people do not agree with the premise that nuclear energy is necessary or desirable in any form. And this disagreement stems in large measure from the issue of growth. It is simply not in the analysis of the nuclear risk, as was identified by Manson Benedict with respect to the breeder. The other viewpoint on the growth issue is set forth fairly well in the article by Lovins in *Foreign Affairs.*[3]

Laying out what constitutes an acceptable future nuclear energy system is, at this stage, more or less paperwork. First of all, we are not going to get everybody to agree to the same acceptable future. And, secondly, we have an enormous problem of implementing anything that anyone does agree on. Because of that

[3]Amory B. Lovins, "Energy Strategy: The Road Not Taken?" **Foreign Affairs,** October 1976.

and the growth issue, we will never get the adversaries to a position where they will be willing to compromise on any sort of paper scenario as to what would constitute an acceptable future.

Just participating in that exercise—and this is one of the things that Dean Abrahamson brought up earlier when he questioned whether he should even be here—provides momentum to the pronuclear faction to proceed. I also know full well that many of them are going to proceed in the "business as usual" fashion and that they have their own ideas of what constitutes a risk. Once they get over the real problems they are having now, they will be back doing more or less the same thing they were doing before the argument. Why give them this added momentum by even suggesting that there is anything out there that even approaches an acceptable system that has any sort of chance of coming into being?

I have some reluctance in saying what I would do if I were in your shoes because everybody would think that I had some hidden motive—that I would not be saying that unless I thought there was some chance we would agree to do it. First, the industry right now is in a comatose state: It is living off the fat of its back orders. And there are a number of people who would like nothing better than to pull the plug on its life-support system and watch it go down the drain. If I were in your shoes, I would, simply in order to survive, seriously look at ways to cut your losses and circle your wagons and do what is necessary to survive for the next decade.

There are two big issues coming up that we really have not confronted head-on so far: the proliferation issue and the waste issue. I think either one of these could really do the industry in unless there is some drastic surgery. (Surgery means that at this stage there is no commitment to Phase II and no commitment to the plutonium economy.)

Now there would be some reluctance on the part of the people in the antinuclear groups to even suggest this because merely suggesting ways for the nuclear industry to survive indicates that if it does survive, it

gets bigger and bigger. And if it gets to 1000 light water reactors under Phase I, then Phase II seems to me inevitable.

What are the benefits of no commitments to Phase II? The immediate benefits to the industry are that while a no commitment situation would not eliminate the proliferation and safeguards arguments, it would really dampen them. If we buried the spent fuel rods directly and did not reprocess, we would certainly have ess of a proliferation problem on our hands.

I would argue that the industry should give up on breeders, should give up on plutonium recycle, and should seek to bury the spent fuel rods, in a retrievable manner, directly and without reprocessing. Now, this does not mean that all of the nuclear problems will go away and that the debate will stop. The debate will still be there on some of the other issues, such as growth and waste.

I would make one other comment about the approach taken by Alvin Weinberg in laying out an acceptable nuclear future. He has taken the present thinking on what the future would look like with so many breeders and made adjustments to that. In his view it is more or less a question of how many technical fixes we need to get more people on board and to get a lot of people to agree that it is acceptable.

There is another approach that we could take and that is to start with the antinuclear viewpoint that the technology is unacceptable and work backwards. This might get us into a whole new scenario. Perhaps the first step would be not to build any reactors at all. I have not really thought that through to see where it would go, but perhaps the first thing we would do before building reactors would be to solve the military waste problem. This would at least demonstrate that we could solve the waste problem before we added more to it. When people start realizing the real problem the country has at hand in solving that military waste problem, they will be very reluctant to commit themselves to a big commercial waste program. And they would be committing themselves to that if they started envisioning these long-term commitments to nuclear energy.

Discussion

Culler

The military waste is large in volume because no attempts were made in the early days to diminish the quantity of liquid waste and the neutralizing agents that had been added.

The civilian economy would produce about 100 gallons of liquid waste (in the primary tanks for solidification) per ton of heavy metal processed—and the French have gone as low as 30 gallons. The military wastes hav considerably higher volume, but the process for plutonium production on military reservations will probably change so that the volume of liquid can be reduced to a very small quantity of solid.

Benedict

It is a misinterpretation of facts to cite the mess that the Atomic Energy Commission and its reprocessing contractors have gotten us into regarding military wastes as an argument against the good technology that is available for dealing with power reactor wastes. The Nuclear Fuel Services facility has also put things in an unfavorable light.

From here on there is no reason in the world why the wastes cannot be dealt with, in the small volumes that Floyd Culler was talking about. Wastes can be put into relatively innocuous forms and safely stored in geologic strata for however long it is necessary without undue cost and without undue effect on the environment.

Culler

Somewhere around 1200 to 2000 acres of salt with waste dispersed on 25-foot centers will take care of the wastes for 800 gigawatts-electric of nuclear power by the year 2000. It is just not a big problem.

Abrahamson

I perfectly agree with Manson Benedict on his drawing the parallel between the military and the civilian waste situation on technical grounds. I am also inclined to agree with comments made earlier that waste management probably should not have been impeded because

of technical difficulties, but rather for other considerations.

But we are talking about making this politically as well as technically viable. And it has to be remembered that over the past few years the nuclear establishment has made quite an issue of the point that we should look at the record when considering accident problems. Someone will remember that and say, "What is the record on waste management?"

I agree with Tom Cochran, in part at least. If the industry would put the plutonium option on the shelf—really and truly put it on the shelf, not just doubletalk about not proceeding—and address itself to the waste issue, my feeling is that the going would be a lot easier.

Willrich

I feel compelled to speak just briefly to clarify where I stand on these issues. First, we have to look at the development of the industry in a world energy sense. If we get off the plutonium economy, that does not mean it will affect the proliferation issue very much. In fact, it is not at all clear that it will not accelerate proliferation in other countries.

Moreover, if we do not find alternatives to oil, it is very clear that the whole energy situation will deteriorate very rapidly. Except for those that have actually been tried and used—coal and nuclear—I do not know what those alternatives are. In a risk/benefit balance, therefore, the risks of not proceeding with nuclear energy far outweigh the risks of proceeding.

One of the things that troubles me about the nuclear energy center concept is the built-in growth rates. If 20,000 megawatts-electric at a shot are added, that assumes something about the growth rate. If they are going to grow organically, however, then there is a wholly different perspective as far as the location of the fuel cycle facilities, etc., is concerned. Basically, I find it easier to think in terms of proceeding with some kind of an organic plan, but with the transitional steps in mind. But if the electricity growth rate is indeed slowing down, that has an impact on nuclear power growth and it is something we really ought to focus on.

There is one point that has been argued long and hard: It is very dubious that plutonium recycle in light water reactors is important. The Ford administration went through that analysis and determined that it was not important. I would suspect that the Carter administration—knowing something about the positions that the preceding administration has formulated—is going to agree with that. It would be a national tragedy for the industry if, at this stage, it tried to go back and urge the Carter administration to rethink the October 2 [1976] statement.[4] That statement ought to be accepted by the industry as a point of departure if there is to be a workable nuclear power industry in this country.

It is urgent that we get on with uranium exploration, expansion of enrichment capacity, and development of some kind of technological stability in the enrichment end, and that we standardize reactors. This has happened in Europe; the French and Germans apparently have standardized much more than we have.

There is a good point to be made about demonstrating radioactive waste disposal techniques. Why not take the military waste and package it safely and get rid of it? The costs will be large, but we ought to move that one forward. And there is no reason why in that process we cannot put in place the kind of institutional arrangements that will endure for the commercial wastes when they come on board.

We [The Rockefeller Foundation] recently completed a study for ERDA in which we came up with some very constructive solutions for the institutional and the regulatory issues, which really do dominate. For example, there is no reason to hesitate in moving the military wastes out of tanks into the ground.

Finally, we have to rethink the breeder development program. It seems to me, as an outsider, that it is in disarray. It has been almost a scandal in terms of the amount of taxpayers' money that for decades has been poured into that program. I would urge people to re-

[4] A discussion of President Ford's statement can be found in the following reference: Richard Myers, "U. S. May Ban Reprocessing, Ford Says," **The Energy Daily** 4:96, October 29, 1976.

think it internationally. The United States has a great opportunity to move the breeder into a reasonable time perspective and energy niche if it would reach out and begin really serious discussions with the French and the Germans and, hopefully, with the Soviet Union and other countries that are moving ahead with the breeder. It is terribly important at this stage to think in global terms because the breeder does mean a plutonium economy. We should at least consider their technology, and if it is good technology, we should accept it. After all, there are very few nations as proud as the French, and they wound up swallowing U.S. technology on the light water reactors. And they have moved ahead with it rather effectively.

But we are just sitting around, incapable of deciding and incapable of managing. And I guess the bottom line is that the energy people of Europe, or of any major industrial country, are angered at the United States because we are threatening their security. If we are to go in and compete with them for Persian Gulf oil in the way we are headed right now, it will be a very unstable situation that will be of our own making.

Cochran

What Mason Willrich said reinforces my earlier remarks about the concern over whether the industry would seriously consider the abandonment of Phase II. To take the breeder from the program it is in now and to internationalize it is really to talk of accelerating Phase II by leaping over some of the problems it has. And I think that if the reaction of the industry were in the direction that has been advocated, rather than serious abandonment of Phase II, then this whole debate certainly would not go away; it would simply heat up.

LeGassie

If we wish to avoid countries that do not now have weapons' technology acquiring such a capability inadvertently as they pursue civilian technology, then we obviously would be willing to see them have a reactor in order to meet energy needs, but unwilling to let them have chemical processing facilities in their territories.

Presumably, the idea is that those countries that have the capability now would offer it and make it available to other countries so they could be assured of complete fuel cycles without having to take the step into the fuel cycle themselves.

Therefore, an argument can be made about the importance of acquiring a domestic capability of reprocessing, not because we want to go to the breeder or view plutonium recycling as economically desirable in side the United States, but because of the internationa milieu in which this whole thing has to operate if the major concern is, in fact, dealing with proliferation.

I would be interested in Tom Cochran's perception of whether this has been thought about by people with whom he talks.

Cochran

The central purpose in not reprocessing in this country is because of the proliferation concern. And we take the position that the external costs associated with proliferation far outweigh the economic benefits of recycling. Now, there are some countries on which we do not have any leverage, and we could not prevent them from building their own reprocessing plants.

There are two foreign policy positions we can take. The first is that it is wrong to reprocess because of the proliferation problem and we will demonstrate to the world by the appropriate approach—which is not to recycle—and we will encourage in every way possible other countries to follow our lead. I would take the position that we could encourage them with incentives as opposed to some sort of "big stick" policy.

The other foreign policy alternative is the one that the Ford administration is, I believe, taking. Namely, since we cannot do anything about these other countries, our best alternative is therefore to get in there and reprocess to the hilt and build better safeguard techniques. This is the wrong approach. Instead, we should not reprocess, and we should turn our backs on the plutonium economy on ethical grounds. There may be some cases where we cannot prevent it just as there are some cases where we cannot prevent countries from becoming weapons states if they so choose.

Commentary

Sidney Siegel

We are fortunate that we have nuclear energy available to us, but there is no necessity for us to use it. I do not believe there would be a national catastrophe if we decided to forego nuclear energy for some decades or forever.

If we passively abandon this opportunity we would be burdening our society unwisely and unnecessarily by denying ourselves an option to use energy from nuclear sources at a time when the other sources are becoming either scarce or difficult to use at the levels we apparently want to use them. Therefore, I think that the issue of finding an acceptable way for deploying nuclear energy to the extent that it is beneficial to do so is a very real one. The obstacles to such an acceptable deployment, because of the state of the technology, are political and institutional—not technical. On the one hand, our political decisionmakers, the public generally, and many of the representatives and executives who stand in their place, are not convinced of the need—in spite of our technological assumption that there is a need for and a benefit from the use of nuclear energy. The other obstacle, along with that political obstacle, is that it is not at all clear that the present institutional arrangements we have evolved are well suited to the requirements of a system acceptable to the general public.

Preceding this issue of acceptability is the issue of recognition of need. Whichever system is acceptable or will be acceptable depends upon the perception of the acuteness of the need. Fundamental to establishing acceptability and need are a better understanding and a better consensus of what can be accomplished by conservation.

There are certainly disaggregated versions of conservation: One can conserve to some degree in electricity use; one can conserve to an altogether different degree in petroleum use. The different opportunities for conservation need to be clarified for the decisionmakers—either the public or their representatives.

A recent article in *Science* on an analysis of the energy use in Sweden[5] shows a per capita gross national product resembling ours but shows that a much different pattern of energy use per capita is feasible with a high quality of life. However, an examination reveals that one of the important differences is in the area of personal transportation. And to return to my comment about disaggregation of conservation opportunities, it is probably petroleum use that provides the United States with the greatest opportunity for conservation. This i where the greatest shortfall occurs, and this shortfall of petroleum can be, in part, helped by increased use of nuclear fuel and coal. It can also be helped by a change in foreign policy.

I have always felt that electrification is a natural and beneficial route to follow. Electric energy is more flexible in its use of fuel and more flexible in its applications. So whatever we do on conservation and however it affects our total energy budget, I come to the conclusion that electrification is an important avenue to pursue and that it will grow.

The fuels that can be used for increased electrification are coal and nuclear. My own point of view is that coal is far more obnoxious than uranium to recover and burn with present practices and with practices that may be available in the next 25 years. I think we would be nationally safer, healthier, and environmentally better off if we minimize our dependence on coal and emphasize nuclear, but we have to find acceptable ways to deploy it.

What I have identified for myself to be a principal characteristic of the nuclear enterprise is the need to integrate a rather large number of diverse activities—integrate them much more thoroughly than was the case for conventional electric energy systems. Uranium mining, enrichment, reactors, reprocessing, and waste storage all have different technological and financial management characteristics. And yet, they must be integrated in a better way than we have succeeded in doing so far.

[5]Lee Schipper and Allan J. Lichtenberg, "Efficient Energy Use and Well-Being: The Swedish Example," Science, 194:4269, December 3, 1976.

We need to build on our present institutional arrangements. A pattern I would foresee as being a more effective one 25 years from now would be some symbiosis of the current electric utility industry's owning dispersed stations—perhaps these are the sites where the present light water reactors are located—and a complex of regional nuclear energy centers owned by utility consortia or owned by COMSAT-like corporations. I do not have the answer to how ownership of nuclear energy centers should evolve. They can be operated by consortia of private enterprises or by individual companies. A good example of the latter is our national communications system, which is operated by a single national enterprise. It is an example of how one private enterprise has done an outstanding job developing the technology that has been exported to much of the rest of the world.

A nuclear energy center could be the way of ensuring that this integration occurs. And, in fact, this is my prime motivation for believing that the nuclear energy center is a good route. I think the intrinsic reasons for developing nuclear energy centers are really more important and more persuasive to me than the concerns about terrorism, proliferation, and other, secondary issues. The idea of a nuclear energy center offers the possibility of integrating the reactors, reprocessing and refabrication plants, and waste management centers in better ways than the dispersed and diverse private enterprises we now have.

Let me now comment on Mason Willrich's point about the disarray of our breeder system and the opportunities for benefiting from foreign development. I believe that our own technology in the LMFBR is as good as that of anyone, including the French. What the French have, and what we do not have, is an integrated approach to the deployment of a nuclear enterprise. They are integrated in the sense that between the Commissariat à l'Energie Atomique, Electricité de France, and a few other industries, the character of the program is being determined.

I would conclude by stating that I am deeply concerned about the notion that we can avoid a plutonium

economy. The only way we can fully use the uranium and thorium resources is by a route that ultimately involves plutonium recycling. Deferring a decision may be an interim measure that has some merit for a limited period, but I have paranoid suspicions that the notion of deferring is simply an argument for ultimately forcing us to abandon the nuclear option entirely. This would be unfortunate and tragic; society simply cannot live with that route.

Discussion

Culler

There is another difference in the French program; their processes for review, licensing, and approval are very different. They allow an integration between decision and construction on a faster basis than we now have in our process.

Selby

It seems to me that this proposal of integration is another way of limiting public participation, which is just why the industry is being tarred and feathered today.

Charles J. Hitch, Resources for the Future

In order to get the energy out of uranium-238 by fission, at some point it has to be turned into plutonium. Thus, there is no way of avoiding making plutonium. If we are going to burn uranium-238, it has to become plutonium at some point, and to fully utilize the energy in it, the uranium or plutonium must be separated. Is this generally accepted?

Culler

The problem of recycling plutonium is to go from about 0.7 percent to 3 percent of plutonium in the fuel, and in the breeder from about 0.7 percent to around 16 percent.

So in order for the fuel to be useful in the reactors, the plutonium has to be concentrated with respect to the uranium, and some processing has to occur. The uranium/plutonium mixture can be run together through the plant and the plutonium concentrated very simply. The uranium/plutonium stream can be decon-

taminated as completely as possible, or the stream can be left hot.

Siegel

I wanted to ask Tom Cochran whether he would find the Canadian system acceptable. They have simply deferred the use of plutonium. Their balance between uranium resources, energy needs, and their reactor system seems to be a wisely selected combination. Would you find that acceptable for this country?

Cochran

The fact that the CANDU [Canadian Deuterium Uranium] reactor can operate without recycling the fuel is an advantage. The disadvantage of CANDU is in terms of the proliferation problem, as opposed to the terrorist-type problem of diversion. CANDU is one of the easier reactors to manipulate and to get a little plutonium out of, bypassing whatever safeguard procedures are in place.

What concerns me about the proliferation issue is that if reprocessing on a worldwide basis and stockpiling plutonium gets started, then a nonweapons state has all of its options open. It can declare that it is a nonweapons state, that it is not going nuclear, and that it is living by all of the safeguards treaties and so forth while knowing full well that it has preserved for itself the option of going nuclear in a very short period of time.

Cooper

The proliferation problem, in terms of an argument about an acceptable nuclear system for the United States, is really marginal. The problem, if it is going to be resolved, has to be resolved on an international level.

Cochran

On the contrary, I think what we do has a great impact on what other countries do. If the Carter administration took the position that we did not need to recycle plutonium, that we did not think it was in the interest of any country to recycle plutonium, and that we wanted to postpone for as long as possible a movement to an economy where all of the nonweapons states are given this option, then I think a lot of other countries would pay attention.

Mike McCormack, U.S. House of Representatives, Washington

It has been said several times and it is important for us to understand that the technological problems are solved or solvable. Of the problems we are dealing with here, there are no unsolvable problems technologically—whether it is recycle technology, fabrication technology, waste technology, or the technology of handling plutonium in a way to reduce the threat of diversion virtually to zero. There is no doubt at all that we can do that.

If we establish reprocessing centers where we go directly from the separations plant into a fabrication system, we can take any one of a series of steps that will reduce the potential for diversion to essentially zero. And we can create enough time to take appropriate action if any person diverts material. I think this becomes a very small problem in the big picture. But we are dealing here with a lot of matters that simply are not understood by the public.

I do want to say that what the United States does in the short run in the international community may have an impact—but only in the short run. The pressure to go nuclear is overwhelming throughout most of the world. And the pressure to reprocess will be just as overwhelming. It seems to me that the critical role that we have to play is to establish leadership—not to prevent this from happening, but to guide it in such a way that we minimize the potential for proliferation.

I see nothing wrong with the United States' reprocessing fuel elements for other countries. As a matter of fact, there are two approaches we can take here. One of them is that we can establish the entire fuel cycle as the property of the federal government. If we had the entire fuel cycle—from yellow cake to waste management—as a federal project with one single system, I believe it would be feasible. If the federal government leased fuel elements to private industry in the United States, to public or private utilities, or to overseas customers on the condition that the elements be returned for reprocessing, I believe this could be done.

The technological solutions are there. It is just a matter of what we choose to develop. Furthermore, I believe that the political solutions exist to go a long way

towards minimizing proliferation and reducing the potential for both diversion and proliferation. The solutions involve recognizing the fact that while this country may pressure the French into not selling reprocessing plants to Iraq, for instance, it is not going to eliminate the pressure of somebody else who is reprocessing someplace from doing so sooner or later.

Weinberg

To some degree we are re-inventing some elements f the Acheson-Lilienthal Plan.[6] And in one sense, a central issue in our whole discussion can be paraphrased: Should we re-invent some version of the Acheson-Lilienthal Plan? So many of the concerns that we have now voiced are concerns that indeed are implicit in the original Atomic Energy Act. It may be that these concerns that were implicit and somewhat theoretical 30 years ago must now become explicit and nontheoretical.

Rossin

I want to respond to Mr. Willrich's comments about the plutonium recycle economics in the Ford statement. The GESMO economic analysis of plutonium recycle is badly flawed; the economics of plutonium recycle are certainly not marginal. When the analysis is properly done, I think this will be more than evident.

The Ford statement was based on extremely narrow advice, on very little public participation, and, to my thinking, on very naive advice. It deserves a tremendous amount of open and thoughtful discussion before it can be even considered as a policy statement.

The new administration will be stuck with dealing with this. And if the administration does not deal with the problem in a broad public debate, it will be a serious example of very narrow and very incomplete thinking.

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[6]"A Report on the International Control of Atomic Energy." Prepared for the Secretary of State's Committee on Atomic Energy, Washington, D.C., March 16, 1946.

Session III

Regulatory and Institutional Issues

Statement

J. C. Swidler

We can look at the institutional problems from the point of view of how government agencies accommodate the existing industrial institutions such as the diverse electric power industry and the complex nuclear industry. Alternatively, we can ask how these industries might be reorganized to function in a more acceptable way.

The comment was made earlier that the trouble with the institutional agencies was that they did not provide answers in good time. In our energy program's present state of disarray, to expect a streamlining of the regulatory apparatus and to expect agencies to be able to make prompt decisions where society is far from being in agreement is to expect too much.

It was suggested to me that it would be a good idea to put on one of the regulatory agencies someone who was opposed to the program of that agency—on the theory that this would lend credibility to its decisions. A lot of that has already taken place. There are people within the agencies who oppose the programs. And it is the purpose of these people to delay and complicate decisionmaking and to frustrate the purposes of the other commissioners.

Congress has made it easier by giving signals to the courts when it was not completely sold on the programs that the regulatory agencies were administering. The

courts have taken the bit in their teeth and have frequently felt free to exercise their own judgment on particular subjects—particularly on the scope of intervention and on the scope and weight of the evidence.

There are inconsistent statutory mandates. It is not always easy to know what Congress intended. The course of legislation to straighten out the substantive problems is tortuous. When Congress refuses to clarify, the legislative histories frequently serve only to confuse further. The concept of participatory democracy—th idea that everyone is entitled to litigate indefinitely and, if necessary, at government expense—has a great deal of legislative sanction and judicial support. And it is a fact that impedes the regulators and gives occasion for some sympathy for their plight.

Frequently we hear recommendations for one-stop licensing in an effort to streamline decisionmaking. To accomplish that requires legislation. It requires that faith be placed in a single agency to accommodate the interests of all the government departments and to reconcile the impact of all the government departments and programs. Obviously, this accomplishment requires some kind of authority for achieving accommodation between environmental and energy interests. There is such a statute in New York, and there may be in a few other states. But most legislatures, and certainly the Congress, have not been willing to entrust this authority to a single agency. The outgoing [Ford] administration has not recommended it, and the incoming [Carter] one has specifically said that the Environmental Protection Agency would not be included within the energy reorganization plan. Realistically, then, the essential problem is that the legislatures, including Congress, are not sure they want the regulatory agencies to streamline decisionmaking.

It is always possible to think of ways to make incremental improvements. When the problem of regulatory delay first became serious, the agencies focused on what they could do within their own domain. Could they require prefiling of the evidence? Was there some way they could limit cross-examination? Could they set up targets for consideration of particular phases of a

proceeding? Could they use two examiners instead of one? There were many efforts to save a week here or a day there. But an atmosphere such as this is hardly conducive to a continued search for saving minutes and days; when the case is remanded, the additional workload is a further embarrassment in trying to clear the calendar.

One of the greatest sources of delay is the requirement for filing an environmental impact statement. These statements take a very long time to prepare and are frequently preliminary to litigation. It may be possible to carve out some proceedings where, without significant impairment, the use of environmental impact statements can be avoided. For example, this could be done for demonstration plants. Valuable time could be saved in bringing something on line that may become a model for many others—perhaps for a whole new way of saving energy or of making energy available more economically—without risking a general deterioration of environmental standards.

There are a couple of fundamental policy questions that Congress needs to decide before we can make significant progress. One of them is on the respective roles of the state and federal governments—especially in siting. For example, should the states be given authority for the nonradiological considerations of siting? Experience has shown that if a state agency has siting authority and wants to look into radiological considerations, it can do so—despite the Minnesota case—on a variety of pretexts. (The New York Commission is in the process of doing that right now.)

The states should have a role, but it ought to be a sharply defined role. The fuzziness and lack of clarity in the respective government roles are an invitation to litigation that is bound to further impede progress in nuclear licensing. That is the case even if we assume that Congress desires to proceed with the program.

Ultimately, when the stridency of the debate has died down, we will need some way of bridging the gap between the energy-producing sector and the environmentalists. Now, when they are at loggerheads the project cannot move forward except by fully adopting

whatever environmental requirements are prescribed. If this cannot be afforded, the project is dropped.

I wonder if this unilateral kind of decisionmaking on environmental requirements makes sense in the long run. At any rate, the ability to frustrate the project through unilateral environmental decisions ought not to be laid at the foot of the regulatory agency that may well have done its job and be as much a victim as a cause.

Next, let me address the very interesting question of the shape of the industry with respect to a viable nuclear program. One of the suggestions made today was that the federal government should take responsibility for electricity generation and transmission, or that there should be a regional agency. It is not clear whether it is necessary to tear the industry apart and then put it together in a different pattern in order to move on these programs. Nor am I sure to what extent these fundamental changes in industry structure represent an effort to make concessions that would win broader support. Unless these concessions stand on their own in the interest of safety, economy, or efficiency, they ought not to be made. Nothing is achieved by restructuring the industry without being able to show comparable benefits.

Mason Willrich made a very interesting suggestion for an organically growing program; this would presumably be presented to Congress in an overall package and Congress, in adopting the package, would eliminate the institutional and procedural barriers and facilitate the implementation of the program. This program would straighten out the front end of the fuel cycle, provide for expansion of enrichment capacity, include some provisions that would make a real standardization program workable (which I assume means some sort of suspension of retrofit or a limitation on retrofit requirements), straighten out the uranium supply problem, and include a demonstration waste disposal program that would cover both military and civilian wastes.

Finally, there is the question of how to achieve some kind of decisional finality. Are referenda, which are based on mutual scare tactics, the right way to reach

decisions on these technologically difficult questions? If these are the kinds of decisions that ought to be made under our system by our legislative representatives, does Congress need more help? Is there some way that Congress can increase the credibility of its own decisionmaking process? Does it need its own science advisory committee? Have we had too many hearings in which the adversary private parties each call upon their own squadrons of experts and publicists? Do we need a reorganization of the committee structure?

The credibility of the decisionmaking process is most important where the most important decisions are made—namely, in Congress. We need to start there and build credibility into the system at every stage. This is not done by inconsistent mandates or by inventing controversy within an agency.

Fundamentally, when we get into serious problems, there is nowhere to look except to Congress. These problems cannot be straightened out except through legislation. We must look to the Congress to try to develop its own procedures and to aid in the improvement of the procedures of the agencies so that these decisions can be made in a way that the public will support.

Commentary

John D. Selby

I will spend a few minutes addressing the problems of the investor-owned utility, which has a unique problem. It is the only industry in America that, by law, must seek permission from its customers to raise its prices before it can raise them. For that privilege, we accept the responsibility to deliver electric power to whomever wants it, when he wants it, and in the amounts he wants.

In that context, inadequate acceptance of rate increases on the part of our customers or inefficient operation on our part spells bankruptcy. So let me assure everyone that there is a great incentive for the investor-owned utilities to deliver power at the lowest

reasonable cost, while making an adequate rate of return for our investors. Our problems would be much easier, in terms of meeting both of those requirements, if there were no growth. We could run our utilities profitably and satisfy the economic interests of the customers by keeping rates down.

I know we are supposed to emphasize the future, and I would cite our particular case as a starting point. Kilowatt-hour sales were up 8.5 percent through the first 11 months of 1976 over 1975. Earlier this montl [December 1976] we had the highest winter demand in our history while the unemployment rate in our service area was over 8 percent. So we must consider that further growth is a reality under the requirements of our service franchises, and the options for additional capacity, on any economic evaluation we have made, limit us to coal and nuclear for the foreseeable future. From my standpoint, a ban on nuclear would probably ease my job considerably. If someone ordained, "Thou shalt not use nuclear," we would do our best with coal or whatever else was available. But as a citizen, a father, and a grandfather, I think it would be absolute nonsense to foreclose that option.

When we look to the future, we are facing a lead time of 10 to 12 years for new generation capacity to come on line, independent of whether it is coal or nuclear. In that kind of time frame, there is no question that things that have not been planned for will happen. The only question is whether or not they are of sufficient severity that we cannot roll with the punch.

Now we can roll with some punches, but we cannot roll with an OPEC [Organization of Petroleum Exporting Countries] cartel that triples the price of fuel. We cannot roll with a Nuclear Regulatory Commission which, after we have invested $400 million in a plant, is holding hearings to decide whether or not it ought to lift our construction permit. We cannot roll with an EPA regulator who apparently has a change of heart—and I speak of the Seabrook problem[1]—and says, "You cannot go

[1]The Environmental Protection Agency reneged on an earlier ruling that would have allowed direct discharge of cooling water into the ocean from the Seabrook, New Hampshire, nuclear plant.

ahead with the kind of discharge you planned on." And that is after some $400 million is invested.

Fundamentally, regulation has to be evenhanded, it has to be timely, and decisions have to be made. And once decisions are made, they have to be stuck with if we are to survive the kind of environment we live in. Therefore, there needs to be a method for resolving conflicting requirements between the various regulatory agencies. At present there is no means by which we can get resolution; therefore, we start out to design a horse, but end up with a camel. We keep putting a Band-Aid on everything until we can finally get agreement from all of the various agencies. This process is expensive, it is debilitating, and it does not use the resources of this world the way they ought to be used.

Joe Swidler has indicated some of the problems with expecting timely responses from the regulatory agencies, and I agree with him. I do not think there is any way that one can expect the regulator, under the environment that we are in today, to stick his neck out to make a timely decision and make it stick. The courts would not permit it, even if he wanted to. Under that scenario, what is the response that industry can come up with in order to try to remain viable? As I see it, the only response that can be made is to say, "No construction; not a shovel of earth will be turned until all final licenses are obtained." From the standpoint of the investor-owned utility—which, incidentally, supplies about 80 percent of the electricity of this country—the second alternative may be more acceptable. We will not be serving—but that will be with a record of diligence in having tried.

Mason Willrich

I would like to crystallize some of the reasons that we have these institutional hang-ups and then discuss the issues that are involved in working toward a way of dealing with these problems.

The growth issue should be high on the agenda as a continuing part of every debate. We need to decide what values we want to have driving the system of the future. This is not an economic issue; it is simply a human issue

that goes to the core of all that makes up human beings. Thus, we have these conflicting perceptions that are being focused in the nuclear debate as well as in a lot of other debates that are going on.

Secondly, the matter of the type of people in the business has been neglected. On paper, one can have all of the policies in the world, one can have beautiful organizational architecture and a great technology; but, it all hinges on the quality of the individuals who are involved.

An issue in the nuclear business is: How do we get the right quality of person who plays a whole variety of different roles, but whose bottom line always is excellence? And this is one very good reason, if we want to make the nuclear industry work, for having excellent adversaries every step of the way. At the same time, real excellence is needed inside the system. And, frankly, I have been disappointed that the issues I find myself occasionally raising with the industry are those that the industry itself has not taken the leadership in raising for itself. How do we get that excellence? If we are to have quality people attracted to this industry, it has to be an attractive place and it has to be part of our system. We can turn off the kind of people needed—this can be done by segregation or by priesthood.

Furthermore, if fission power cannot be reconciled with the basic political values that have made this country, then it is clear that at that point it is shut down. Our political institutions do not revolve around nuclear energy. It is just the reverse. And this is where the attention ought to go; there is a lot of room for improvement in the process, both in government and in industry.

I have watched carefully our friends in the NRDC [National Resources Defense Council]. I think they are performing a public service by being excellent critics. And I have watched, with some care, the precision and professionalism of the lawyering that has gone on. Given the framework that has been provided by the Congress, legislation, and regulation within which lawyers have to operate, they have been highly professional. They have done a first-rate job with limited resources

against law firms and aggregates of economic power with virtually unlimited funds to spend. One may not like the institutional framework in which they have operated; nevertheless, they have done a highly professional and precise job.

I agree with Joe Swidler that the federal/state relationship problem is a key relationship that is not yet resolved in the overall energy field. Until this relationship is resolved, we will be without an energy policy and we will be an increasing threat to the security of a lot of other countries because of our inability to put it all together.

A second relationship that is equally important and difficult is basic government/industry relationships. If the nuclear enterprise is to continue, the public must be confident in that relationship. This has to be worked at with ERDA, between the regulator and the regulated industry, and, more basically, with the industrial leaders so that they will be able to go to Washington and have some frank talks without leaving Washington under suspicion that they are ripping off the country. This is an international issue of some moment as well.

I would like to conclude with a couple of remarks about proliferation. The civilian nuclear industry can be separated from nuclear weapons proliferation. In fact, it has pretty much been separated. For example, in Britain and France the military programs came first where they had mainly plutonium and then a little bit of electricity. But even in India, material was not diverted from industry but rather from a research-type reactor that was primarily good for plutonium production.

In the proliferation area, the major feature that makes civilian fission power workable within this framework is the fact that it gets easier for countries to get nuclear weapons outside the power industry. As time goes on, the industry can be disconnected by applying safeguards that will raise the cost of diversion sufficiently so that a country or government that plans to go into the weapons business will do so in a very straightforward, simple, and direct way.

If we are moving into a plutonium economy, and if

the breeder moves forward, then I would urge that we try to internationalize it and that this be carried out cooperatively rather than competitively. The reason we really want to reprocess is for breeders; we ought to be clear on that. If breeder reactors cannot be developed successfully, it is highly dubious that we would want to reprocess for recycling in light water reactors; we do not gain much before fuel runs out.

On the other hand, if the breeder is to go forward and if we are into a plutonium economy with huge flows of plutonium, then institutional arrangements to manage that material—this applies to hundreds of thousands or even millions of kilograms in the long run—should be properly handled on a multinational basis. I do not mean that in the worldwide sense, but there are gains to be achieved by structuring a multinational industry, especially in terms of the back end of the fuel cycle and its waste disposal facilities.

Discussion

Cooper You made reference to nuclear energy as not being "special." I would like to take issue with this by way of analogy. If a dam caves in and lots of people are killed, it will not set back the hydroelectric program. If a mine caves in and lots of people are killed, it will not set back coal mining. But if there is a major nuclear accident, I warrant that there will be a Presidential nuclear moratorium.

Willrich All I meant was that we want it [nuclear energy] embedded into society. In other words, I want to know the people in the nuclear industry. We do not want to separate it into some sort of special thing that is isolated socially.

Culler You said essentially that we did have to pay attention to growth in the requirements for energy, and particularly nuclear energy. The problem that I have each time I hear this statement is to know whether or not we are going to direct the aspirations of society or let society seek its own level and then attempt to re-

spond to the demands that develop. Which do you think, in a democratic society, is the way to go?

Willrich

I think we have to respond. But when we do respond we should look at the energy demands, and we should talk to the environmentalists and the no-growth advocates about the structure of this energy demand. Then we should work out the proper system.

Sporn

There is a complete contradiction even in concepts between international interdependence—which is what we are talking about when we are talking of an international breeder society—and a system in which the energy demand in any particular segment or any particular nation is something that is determined by that society with the energy part of that society responding to that development. There has to be coordination between these ideas of interdependence. We have to consider what the rest of the world needs in the way of energy and what we are going to allow our own growth to demand.

Cochran

If reprocessing is only justified with the breeder program, then the back end of the fuel cycle and this whole recycle industry becomes part of the breeder program. The present breeder program is at about the $10-billion level. Everyone would agree this is an underestimate because this does not include fuels for the half-dozen follow-on plants. So we should add another $10 billion for those, plus another $9 billion for the back end of the fuel cycle. How do you justify economically the breeder program that we have today—at the current pace—at that sort of cost?

Alan D. Pasternak, Energy Resources Conservation and Development Commission of California

I would like to come back to a number of comments that Joe Swidler made, because many of his comments that were directed specifically at the federal level certainly have their parallels at the state level from my own experience during the last two years.

He mentioned efforts to streamline the process through one-stop licensing. That is certainly one of the

motivations in establishing an electric generating licensing agency in California. It yet remains to be seen whether that is possible. It will depend on how existing laws are construed and how the members of the commission actually proceed.

It is not at all clear that the California commission is a one-stop licensing agency even though the legislation clearly indicates that this was the intent. Mr. Swidler mentioned the problems of judicial review, reversals, mandates, and fear of reversal. We certainly have that parallel. We have already suffered one judicial reversal—which is now on appeal. We suffer from inconsistent statutory mandates within the state law itself.

The issue of institutionalization of the opposition I do not see as a problem. I am more sympathetic to Mr. Willrich's point of view on this. We do have special counsel provided for interveners, and we are now attempting to provide compensation. It is my own view that the special counsel route is far more preferable to the compensation route. The success of that particular effort really depends upon the individual who is that special counsel. We are already putting members who oppose the programs to be administered by a regulatory agency on that agency in order to lend credibility to its decisions; we have possibly two members who fall into this category. And I must ask the question: Must total paralysis be the price of credibility?

On the question of relaxing the requirements for environmental impact reports of demonstration plants, I would say that I am not sympathetic. Given the complexity and the difficulties of working within the regulatory process, the exercise of that process itself is, in many cases, an inherent part of the demonstration. This is certainly true with the Clinch River Breeder Reactor, and I think the demonstration involves an exercise on both sides. The viability of the technology is being tested within the regulatory framework, and the regulatory framework as it applies to that technology is being exercised. That is an essential part of the demonstration project.

Finally, I would come to what I consider the most important issue, and one that does bear directly on the

viability and acceptability of nuclear power: the respective roles of the state and the federal governments. I think it is very, very important, and particularly so in the nuclear area, that those respective roles be very clearly defined and scrupulously and mutually respected.

This is perhaps an unusual position for someone from California to take. California is in the vanguard of crossing those lines and dropping that mutual respect that, in my opinion, is really vital. Joe Swidler said that t appears that in New York the siting agency is beginning to exercise, or attempting to exercise, some examination of the safety role in siting. We are also considering this issue, but I really do not think it is wise in the long run to do it. At best, it is a duplication of effort and is wasteful of manpower, time, and resources. At worst, it creates confusion and uncertainty. And if there is one thing that those of us who are regulators have an obligation to do, it is to clear away confusion and uncertainty, insofar as it is possible. Where there is competing and overlapping authority—particularly in the area of nuclear safety—there is confusion and uncertainty. Those who are regulated do not know how to proceed and, if they do, they proceed at a very high risk.

We have on the books in California legislation that ostensibly deals with the area of nuclear safety. It is my obligation to implement that legislation as efficiently and as accurately as possible, and I certainly intend to do that. But at the risk of getting myself in trouble back in Sacramento, I should say that the legislation is not good legislation. It runs counter to present federal policy. In California it is now essential that there exist reprocessing technology before a plant can be licensed. And while at the Presidential level serious reconsideration of that whole effort is underway because of concerns over safety and proliferation, in California we require that a demonstrated technology exist before a nuclear plant can be licensed. Does that make it safety legislation? Furthermore, the legislation is not well written in that it applies to nuclear power reactors requiring reprocessing.

The lawyers tell us that the usual procedures for statutory construction require one to attempt to give a

meaningful interpretation to the law. One cannot just look at a piece of legislation and say, "Gee, that is the world's biggest loophole. Why don't you just drive on through it?" We cannot do that, but that is just one example of the many things in California legislation that will require interpretation.

The main thesis I have is that the line should be carefully drawn, and that safety belongs to the federal side. But there are very important questions that belong on the state side—questions about land use, water use, perhaps the issue of need, that is, those things the state agency, at least in theory, is closer to.

Abrahamson

It seems to me, as Mr. Pasternak mentioned, that if a demonstration plant is, in fact, to be a model for many others, that is all the more reason for ensuring competent environmental review. And if there is one place to have a full and complete environmental impact statement, that is the place to have it.

State authority is a little ticklish, and it comes up in certain other energy options as well. I would expect that there will be substantially expanded state authority over all energy enterprises, including nuclear, regardless of the implications that this may have to safety considerations.

In connection with the decisionmaking process, we have an unfortunate situation with the atomic energy enterprise in that it was well underway before there was any discussion of whether we should do it or not. The debate that is going on now should have happened 20 or 25 years ago. I do not see any resolution of it until there is essentially a consensus.

Swidler

On the question of the environmental impact statement, I would agree that the concept of having environmental impact statements for demonstration plants is a good one. However, that process has been judicialized and has become a technical step in an injunction process or a litigation process. If there were some way of requiring environmental impact statements without making the question of technical adequacy a subject of litigation, I would be all for it. It is not a desire to avoid

the study of environmental implications but the fact that they have become part of the litigation game that precipitated my suggestion.

Abrahamson

I have yet to see an impact statement in which the agency staff that prepared it was not basically sympathetic with the action proposed. The only thing that prompts anything like candor or completeness is the threat of reversal on inadequacy. If that judicial review removed, the whole thing may as well be scrapped.

McCormack

I will try to respond to the question of the institutional programs that are affecting the acceptability of nuclear energy. First of all, the buck stops with Congress more than it does anywhere else as far as ultimate decisions are concerned in a normally functioning system. Unfortunately, the system has not been functioning normally. Activist courts and activist judges have clearly taken it upon themselves to stretch to a point of absolute distortion the original intent of NEPA [National Environmental Policy Act]. We saw that in the recent case in which NRC was obligated to delay licensing based on a court interpretation that was bizarre at best.[2]

It is up to Congress to try to correct some of the problems that exist today. However, I want to point out that the people of this country do trust some leadership. The fact is that both President Ford and President-elect Carter are trusted and respected by the people of this country. And a recent Harris poll showed that scientists were greatly respected as a community by the people of this country.

I think I caught the inference that it was not up to us to lead but rather to respond. If that is what was intended, I want to violently disagree. We can provide leadership in a responsible way in a participatory democracy—this is our obligation. To sit around and say, "In a democracy we just let the masses do what

[2]In mid-1976, the Washington, D. C., Court of Appeals ordered that the Nuclear Regulatory Commission could not issue licenses. This situation lasted almost three months. See Richard Myers, "Appeals Court Turns NRC Upside Down (Again), **The Energy Daily**, 4:85 (October 13, 1976).

they want and wander around," is, I believe, irresponsible. The history of this country, gentlemen, is a history of bold leadership by individuals or small groups.

So to me, this is a peculiarly unreal discussion in that so much of the future of the nuclear industry depends upon one person—Jimmy Carter. Mr. Carter will have the opportunity to appoint three new members to the NRC between now [December 1976] and June. He will have authority, given to him by the Congress, to propose reorganization plans that will become law unless vetoed by the Congress within a certain length of time.

He will be in a position to reorganize for energy and to enunciate energy policy for this nation. He will go on television as one single spokesman, the representative of the people, speaking to the people as their leader and to the Congress, the servants of the people, with a policy and with programs to implement that policy. These things will come to pass within the next four or five months. And depending upon what he does, all of this may or may not have meaning. But if, for instance, he does come down with recommendations for programs to the Congress, we can perhaps work with him to clarify some of the problems and establish institutional programs under which nuclear energy can move forward.

I agree that reasonableness should prevail. This applies particularly with respect to licensing and the regulatory procedures. NEPA has been distorted beyond all imagination of the people who wrote, proposed, debated, or voted for that bill. And I believe it is high time that we go back and have review and oversight hearings on it and see what amendments are necessary to make it do what we intended that it do—provide environmental protection, but not be used as a weapon to prevent progress.

The action stripping the JCAE [Joint Committee on Atomic Energy] of its authority is a major loss for the country. The JCAE would have come up with siting and licensing legislation. This legislation has already been substantially drafted. Many hundreds of hours of work have gone into preparing it, trying to streamline licens-

ing procedures, and trying to establish state and federal relationships.

Incidentally, some of those state/federal relationships have worked pretty well. For instance, in Washington State we have a one-stop system that treats the nuclear power plant as a black box with certain characteristics. But the state controls everything outside that box. We have licensed five plants in the last two years and will probably license two more in the next couple of months.

I would suggest that in a great deal of what we say today, we should be speaking directly to President-elect Carter because, as I have said, so much of what is going to happen depends upon what he is going to do and say. He can rally public support by going to the people; he can enunciate policy—such as the policy of establishing goals, which Phil Sporn talked about this afternoon. And if he does that, then the Congress can and will act. And we can perhaps act in a rational atmosphere to correct some of the problems that exist and eliminate some of the delays.

Brown

This discussion of regulatory systems and the environment relates directly to the major question we are discussing of whether there is a long-range acceptable scheme for nuclear development.

We need a framework of policy, and we need a coherent strategic plan. It may be that in developing that framework of policy and that strategic plan we will have to make some compromises. It is conceivable that Phase I may have to be stretched out. We have been thinking in terms of 25 years; we might have to think in terms of 50.

We do have to have a plan, however. It should probably encompass some realistic goals as to the number of light water reactors that we will license and bring on line each year over a period of time. It will have to outline some broad guidelines as to regional and local siting for that period. It will have to provide for making up the slack, because we cannot precisely predict demand or other supply factors. If we have a strategic plan and if we are serious about it and about

the policies, and if we want to cut back on oil imports, we can accomplish the plan. We know how to do it, and within that kind of framework, many of these regulatory problems could be solved with very little difficulty.

I personally favor very strong environmental safeguards on nuclear, coal, and any other types of power plants. The public health and welfare, the health of the environment, and the protection of wildlife are all very important.

However, I am very resistant to the use of these concerns to delay things that need to be done for the welfare of the country. If we are operating according to a rational plan, we can set up a site acquisition authority and acquire sites long in advance of the time we will need them. And we can have the environmental impact statements prepared, insofar as they are site specific. And we can work out the geology, the seismicity, the ecology, the water supply, the meteorology, and all of these things in advance. We can do this for all of the sites if we need to. And we can have that all out of the way before we are ready to license.

We can do the same for standardized technology. If we have a plan and if we adhere to it, a good deal of the technologically dependent impact can be worked out in advance. We can cut down the licensing time and the other time factors by two to three if we use a little common sense in advance planning. This will require a consistent policy and planning framework within which to operate.

Weinberg

The debate that has gone on this evening has been primarily concerned with the question of how to more adequately implement nuclear energy systems that are deemed acceptable by those who generally accept nuclear energy. It has not been aimed at what I think is the more difficult question of identifying the institutional issues raised by those who do not like nuclear energy.

Therefore, the suggestion that George Brown has made is very much at the heart of the matter. If we could somehow come to some agreement as to what

the criteria are for an acceptable nuclear system, then it seems to me that a consensus would be developed, or there would automatically be a consensus, and that many of these seemingly intractable regulatory and other institutional issues would turn out to be not nearly so intractable as they now seem.

Jack N. Barkenbus, Institute for Energy Analysis

Before we have a framework for policy and a strategic plan and some institutional continuity—instead paralysis—we have to somehow resolve the value differences that others have alluded to. While these may appear to be irreconcilable, I suggest that we have not yet really given any imagination to bringing these divergent values, and the people who hold them, together in the proper forum. We need to see just how divergent they really are.

I suggest that we start thinking about institutions or forums that can be devised to give legislators and regulators a better signal about what society will or will not accept. We all recognize the inadequacies of the initiative process as a forum, and therefore I will not recommend it.

Another forum that has recently come onto the scene is the science court. I do not advocate it to resolve the nuclear issue, but I simply raise it as a new institutional means to try to work out some of these value questions. I do not recommend the science court because such a forum should consider values, not be based on an adversary process. Also, the forum should not be centered on the elite; we should search for the widest possible public participation, and this gets to the question of who "the public" is.

LeGassie

I would like to suggest the possibility that the problem is not so much with our critics but with ourselves. Our critics have asked us to define how this entire system will, in fact, operate and how the issues that are generated will, in fact, be dealt with. We are unable to do that, and until we do, we first have a problem with ourselves.

Session IV

Near-Term Issues

Statement

M. J. Ohanian, Institute for Energy Analysis

Our discussions yesterday afternoon seemed to center around the nearer-term issues rather than the topic of that session—the long-term considerations. The major reason for this seemed to be due to our perception that if Phase I is not viable, we will not, in fact, have a Phase II. Probably another reason was the difficulties of projecting much beyond 25 years.

Let me at this point reemphasize the main objective of the workshop: to explore the ingredients of an acceptable nuclear system in the nearer and more distant future. In fact, the key question for this session is the following: Are our present institutional and technical systems satisfactory for the nearer-term systems, and will they remain satisfactory for the Phase II systems? Last night we were trying to adapt the institutions that surround nuclear energy to nuclear energy rather than the reverse. It seems to me that we should try to see what adaptations we need to make to the nuclear system to make it fit into our overall institutional structures.

Let me briefly mention some of the near-term issues that need to be considered. The time frame we want to consider spans the next 15 to 25 years—the key light water reactor phase. One issue is reactor safety. Basically, the question is: Are we willing to live with the conclusions of the reactor safety study?

Specifically, can we live with the estimated probability of a core melt accident of one in 20,000 reactor-years, keeping in mind that only one event in 50 of these would be of sufficient magnitude to result in the loss of life? Is this an acceptable level of risk?

In essence, these numbers imply that when we have Phase I fully deployed—that is, on the order of 600 to 800 gigawatts-electric from light water reactors—there is a reasonable chance that we may face one core meltdown during the lifetime of this phase. This would not necessarily be one that would lead to significant effects, however. Can we accept this? If we cannot and we have to require a lower level of risk, what must we do? Do we go about it by way of technical fixes, for example, by hardening containment? Or do we continue to site nuclear plants in remote locations? Can we live with what has come out of the reactor safety study, recognizing that although there will be improvements in safety technology, it is difficult to visualize that they will result in orders of magnitude improvements?

A second issue is the back end of the fuel cycle. We all agree that this is a major stumbling block because of its two key components. First we have the question of reprocessing and the intimately related question of waste management. In yesterday's discussions, there was general agreement that the waste management issue needs to be resolved as rapidly as we possibly can. In fact, the point was made that we should essentially get on with the business of selecting the repositories, i.e., the present ERDA plan should be implemented.[1] Is this plan satisfactory? What changes need to be made? Should ocean bed disposal be considered? Who ultimately makes the decision on the waste management process? What specific sites should be selected?

Intimately tied to this is the question of reprocessing. In fact, if we forego reprocessing, which really says we forego the breeder, then the waste management problem is a different magnitude problem in that we

[1]The ERDA plan involves a nine-year time frame from publishing technical alternatives in 1976 to commercial-scale operations in 1985. See **The Energy Daily**, 4:96 (October 29, 1976).

have to worry only about the wastes from Phase I.

A related question is: Do we need reprocessing today or can it be postponed for 10 years or so? Should that be coupled to the breeder program only? Is recycle in light water reactors an essential criterion for acceptability in Phase I?

These are the main issues that I see with respect to the back end of the cycle. I do not think we have any agreement about what we should do about reprocessing. But, again, let me emphasize that in my view the key issue is whether recycling is really necessary for light water reactors or whether the reprocessing question should be tied to the deployment of the breeder only.

A third issue is, of course, proliferation. Mason Willrich and others talked about this in some detail yesterday. Here we are talking primarily of institutional fixes. I had the feeling that we were in agreement yesterday that the collocation of reprocessing and fabrication facilities was essentially a good thing with respect to minimizing proliferation. This has to be tied in with the idea of the regional reprocessing centers if it is to eliminate a vulnerable link, and it seems to me that the proliferation issue has to be addressed as an urgent near-term issue if we are to have long-term viability of this business.

A fourth issue that we dealt with at some length last night was the institutional aspects. The central issue here is Are the present institutional arrangements satisfactory? And if they are not, what specifically should be changed? To paraphrase Roger LeGassie: Can we rely on the evolutionary process, or do we need something more than that?

These four issues, I believe, are the near-term issues that need rather immediate resolution. We need decisions on acceptable risk, on the back end of the fuel cycle, on what needs to be implemented with regard to proliferation—which is very closely tied to the question of reprocessing—and on some of the institutional questions.

There were some other questions that were emphasized yesterday and that need to be brought up again. One is the issue of standardization. Here we are talking

about a technical fix to speed up construction schedules. It seems to me this would go a long way toward resolving some of the problems in getting plants on line in a timely fashion. We have talked about standardization for at least four or five years, but we still seem to be in an evolutionary process.

Another issue is the uranium supply market and the question of how much uranium we really have. Basically, if we do decide, through the exploratory programs that we do indeed have more uranium, the whole question of the breeder and reprocessing is put on a somewhat different time scale. We would have a little more time to put everything in order for the long-term future.

In addition, there are some other questions related to the transitional phase from the light water reactor system to the breeder system. In this connection, let me bring up just two issues. We have always talked about nuclear energy centers. And I know some of you feel very strongly that we should not go that route. The question I would like to raise is this: Why not have one demonstration nuclear energy center that can be developed before the end of the century so we can look at the practicality and feasibility of the whole concept, rather than just dismissing it? The other question has to do with the longevity of present light water reactor sites. If we are to have a breeder system eventually, then it seems that we will have to use many of the same sites that we are using for the light water reactor systems today. Does this seem practical?

Much of what I have outlined here has already been brought up in yesterday's sessions, which dealt generally with other concerns. I hope this brief review will help us focus on these urgent near-term issues, the specific topic of this morning's session.

Commentary

A. David Rossin

Even though some of the questions Jack Ohanian raised may seriously affect the viability of nuclear power as a future option, nuclear is an existing and

operational technology today.

I am not a nuclear ideologue, even though I have been characterized as such; and I do not think utilities are either, as John Selby made clear yesterday. We have a technology that will be used if it is viable, acceptable, and if it shows up better than the alternatives when the choices have to be made. It has been shown to be acceptable in many instances already. The fact that cannot be underestimated is that the initiative votes showed that the technology, while causing worries to people for any number of different reasons, is an acceptable technology to the public at this time.

I have no dispute about the collocation of reprocessing and fabrication facilities. I see no logic or justification, and some serious drawbacks, to the collocation of waste disposal facilities with a reprocessing and fabrication complex. In one case the consideration is geological, the other has entirely different siting considerations. There are substantial drawbacks to the collocation of generating capacity with reprocessing. One of the more obvious ones is that the two elements serve different purposes. The economies and the logic of scale say that it does not make sense to build reprocessing facilities for half a dozen plants. Between now and the year 2000, even if the energy center concept is adopted, it would only be in one or two places. And the number of units that would be on line by the year 2000 in an energy center would not be 20, and might never be more than 10. This is not logical in terms of the capacity of a reprocessing plant. As for breeders, I think that is something that will come up in terms of the economics of the situation and the suitability of a particular site. That is, the decision will be on an individual, not generic, basis.

With regard to the safety question, I believe that unless we can design, build, and operate plants using the ground rules that have been established within the design-basis accident concept (which is designed not to result in a release that causes substantial harm to the public), there will be no nuclear power technology. But the fact is that the record and studies show that we can do it. And on that basis, I find the kinds of discussions

of guidelines about the population density 30 miles away from the plant to be totally irrelevant.

What are the real problems with the acceptability of the technology? I believe the major one is public understanding. And I am not giving a cosmetic speech; I am extremely serious. The demands of people for facts have increased substantially with the visibility of the issues; this was true in all the initiative states. It is time that we, on an even broader basis, identify documentable facts, differentiate these from opinions, and en the double standard. For example, the recent Council on Economic Priorities report[2] is so badly flawed that it will not hold up under any kind of real scrutiny; we will be publishing a critique[3] within the next couple of weeks. I expect it [Council on Economic Priorities report] to be used in the future in rate cases, and those who use it should be subjected to very severe challenges and be required to show why they think that report makes any sense.

It is time to challenge those who are in the nuclear debate to get their cards on the table. If the issue is growth—and Tom Cochran has explained to us it is foremost in the minds of quite a number of people in the nuclear debate—then let us get that on the table and let the public decide how they feel about that issue.

Next, let me address the subject of waste disposal. Those of us who were in Chicago at the meeting on the nontechnological aspects of waste management talked to several people who were opposed to nuclear power.[4]

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[2]Charles Komanoff, **Power Plant Performance–Nuclear and Coal Capacity Factors and Economics,** Council on Economic Priorities, New York and San Francisco, 1976.

[3]A. David Rossin, ed., **A Critique of the Report *Power Plant Performance* Published by the Council on Economic Priorities,** November 30, 1976. Commonwealth Edison Company, Chicago, January 27, 1977. See also Ronald L. Simard, **A Critique of the Council on Economic Priorities Text *Power Plant Performance–Nuclear and Coal Capacity Factors and Economics,*** Oak Ridge National Laboratory, ORNL/TM-5846, May 1977.

[4]Harrison Associates (eds.), **Proceedings, Conference on Public Policy Issues in Nuclear Waste Management,** sponsored by Energy Research and Development Administration, Nuclear Regulatory Commission, National Science Foundation, Council on Environmental Quality, and Environmental Protection Agency, October 27-29, 1976.

And they were absolutely furious that they had to sit through the ERDA presentation at that meeting. They thought there was no justification whatsoever for spending time at that meeting and listening to a presentation by ERDA about its plans for waste disposal. They had never heard such presentations. This was a moral issue, and they wanted it discussed on moral and philosophical grounds only.

One of the other basic questions of this debate, vhich Dr. Weinberg laid before us, was the question of how to come to accommodations and how to achieve a meeting of minds. I have no delusions about trying to reach a meeting of minds with Dean Abrahamson or Tom Cochran. I think my responsibility is to speak to the same audience they do. The question is: Who is the audience going to believe in the long run?

In that regard, I am struck by a comment I have heard from a number of people at this meeting about the responsibility of the public utilities. I have been impressed by the extent to which the management and the people who work for the company I have been associated with for four years are in contact with the public. Their involvement is much greater than that of the people whom I deal with in government, academia, and manufacturing. The utility people are involved not only in extensive public hearings and in making speeches, but a higher percentage are involved in local community and civic activities than is the population at large. This is in addition to the tremendous day-to-day contact with the customer. Thus, they have much better feel for the public's concerns.

In that regard, I want to read a short paragraph from an article entitled "Edison's Nuclear Gamble." And the question is: Will cheap power cost too much? The article ends as follows:

> *If in this research I have encountered a logical position, vis-a-vis the future, it comes from Gordon Corey, Vice Chairman of Commonwealth Edison. Corey is one of those who contends that nuclear power is now 25 percent cheaper than coal.*
>
> *"But," Corey is quoted as saying, "I don't consider*

a 25 percent nuclear price advantage at this moment to be significant. If coal had a 25 percent price advantage at this moment, I wouldn't consider that significant either. When we build a generating plant of any sort, we must think 40 years in advance. We hope to be 50 to 60 percent nuclear eventually, but we will never put all of our eggs in that basket. We will always be 30 to 40 percent coal and about 10 percent oil. If coal starts to show an advantage, we will reduce our nuclear ratio. No one can see 4(years into the future, so we must keep our options open."[5]

Keeping our options open is the key to this whole issue. If reprocessing and recycling in light water reactors is economical, the utilities will do it if the option is open to them. It seems to me that foreclosing this option is a very, very serious choice and one which right now will not be palatable to the American people.

The reprocessing option has obvious effects on uranium and coal prices, and it is crucial that we be able to demonstrate reprocessing. If $1 billion is sunk into the Barnwell [South Carolina] reprocessing plant and its associated facilities and if the costs of reprocessing fuel turn out to be too high, it will be a large and costly mistake. But it seems to me that $1 billion is a very small fraction of what we will have to spend overseas because of the increase suggested by the OPEC countries.

I want to point out that if the reprocessing option looks closed and the issue is not resolved in the next two years, I seriously doubt that many nuclear plants will be committed in the following years. Then uranium prices will go down, and coal and imported oil prices will go up, and the question, "Which of those options do you really want to commit yourself to?" will be answered.

The Fri report has two options.[6] The one calling

[5]Daniel Rottenburg. "Edison's Nuclear Gamble." **Chicago Magazine,** 25:12 (December 1976).

[6]Robert Fri, deputy administrator of ERDA at the time, directed the research for President Ford's policy statement of October 28, 1976, that said the U. S. "should no longer regard reprocessing of used nuclear fuel to produce plutonium as a necessary and inevitable step in the nuclear fuel cycle." See **The Energy Daily,** 4:96 (October 29, 1976).

for a large-scale demonstration program for the back end of the fuel cycle is eminently logical. The other strikes me as a throw-in, and it is unfortunate that the latter was selected. I do not think there is a difficult problem in safeguarding commercial nuclear fuel either at the power plant, in reprocessing, or at any other stage of the process.

One of the things that disturbs me is the prospect of a nation that does have nuclear energy and does have a lot of very valuable spent fuel containing a lot of plutonium sitting around. They are paying interest on it but with no economic chance to do anything with it. It seems to me this would provide a strong incentive to divert some of the material. Keeping the United States out of the arena as a dependable supplier of reprocessing services is the last thing we want to do if we want to prevent proliferation.

My final point is that there are risks if the utilities throughout this country cannot plan for the future and if they fail to provide the necessary generating capacity. I submit that before very long we must face up to the question: Who gets the energy when there is not enough to go around? I am not talking about blackouts or brownouts. That is an emergency situation. I am talking about looking ahead to firm commitments that will be made to supply people with energy. The electric utility industry will then begin to face the kinds of situations that many gas companies are already facing; that is, making unilateral decisions—because no one else will make the decisions—about whom to cut off. And I have heard no congressman and no state legislator talk about opening public hearings on the question of who gets priority for energy when there is not enough to go around.

Alan D. Pasternak

I will try to restrict my comments to the near-term and focus on the issue of acceptability from the point of view of the public, although acceptability is not necessarily the issue that technical people would focus on. I do not know of any other technology that has been put through the same kind of scrutiny and has been forced to go through the same kind of public

political process as nuclear power has. And in realistic political terms, I think we have to view those votes as a significant vote of confidence. Many commentators do not view it that way and do not consider the defeat of the initiatives as a green light for nuclear power. That is really a truism; no energy technology has a green light today. There are just too many economic, environmental, and regulatory constraints to give anything a green light.

The California initiative was very long. And while a number of us became very familiar with the details of it, I do not believe the majority of the people who had to vote on that measure along with 14 others could quote it chapter and verse. Therefore, for the majority of the voters, it was a vote on nuclear power per se. I suspect this was true in other initiative states.

It is often claimed that a two-to-one margin indicates that one-third of the people have serious concerns. I would simply point out that in a political process a two-to-one vote is normally a landslide. So, within the context of the rules of the game by which elections are played, I think these votes have to be considered as significant. Those people who have responsibilities for regulation or safety have to take these votes seriously.

What will the issues be? I think economics and reliability are very important. These are two issues that have not been spoken of very much in the last day and a half, and as Mr. Rossin indicated in his reference to the work by the Council on Economic Priorities, economics is now a very important focus of attack. That issue is the one to which the consumer looks on a monthly basis, whether or not he is reminded of other important issues, such as the availability of uranium or the safety of plants. He will think about reliability perhaps even more frequently if there is a serious reliability problem in his area—as there was in Sacramento with the poor performance [i.e., low capacity factors] of the Rancho Seco plant.

When is nuclear power appropriate? Is it appropriate to install it in a small municipal utility system (a hydroelectric-based system)—which, so far as I

know, had not one other single thermal steam plant in its system—and impact upon that [municipal] system with what was at the time the largest nuclear plant west of the Mississippi?

What kind of reliability problems are we inevitably creating when we do that? I think this gets back to Dr. Weinberg's concern about the technical capabilities of the people in charge of the operation. In this particular case, their backgrounds were with hydroelectric. What kind of human and technical resources could be brought to bear when they ran into some problems? Obviously, this is an important problem of reliability. It is one that regulators might look at.

Closely tied to reliability, of course, is the issue of uranium supply and enrichment capacity. If somewhere along in the early or mid-1980s we suddenly find that a few plants have to shut down because they cannot get enriched uranium, one can imagine the impact on public acceptability. The economics alone would dictate a rapid increase in enrichment capacity. If we are running now at 0.25 percent to 0.3 percent on the tails enrichment, we are far away from the economic optimum, given the present price of uranium oxide and the present cost of separative work. The tails should probably be below 0.2 percent—perhaps 0.15 percent is closer to an economic optimum.

Congressman McCormack said yesterday that these facilities should be kept within the purview of the federal government; probably the facilities on the back end should be also. And at least one reason for keeping them within the purview of the federal government is that decisions, particularly on the back end of the fuel cycle, will not be largely economic decisions or those kinds of decisions that drive economic enterprises.

I do not want to get into proliferation much except to talk about proliferation of institutional responsibilities and its relation to public acceptability. We are living in a time of uncertainty. There is a lot of attention on forecasting, largely because it is so much more difficult to forecast today than it used to be. And in a time of uncertainty, shortages, and higher prices, do we really

serve the public by proliferating institutional responsibilities and making it harder for the public to affix accountability and authority?

If the public wanted to look to Congress, they could affix responsibility to the Joint Committee on Atomic Energy. If, however, that committee is disbanded and the responsibilities spread among five committees in the House with authority in the atomic energy area, is public acceptability elevated? I doubt it. Perhaps the same thing is true on the administrative side. If there were one Atomic Energy Commission, the public would know where to look. Authority and responsibility are diffused as the responsible agencies proliferate.

The same is true in the area of state and federal responsibility. It is very important that we be able to know who is responsible for what on either side of the state/federal line. And, again, it is important that we be very clear that responsibility for safety issues, particularly radiological safety, be left where it has traditionally been—on the federal side—and that attempts by the state to encroach on that side be firmly resisted.

There is one other point I want to make on proliferation in its more traditional sense. It is one that Phil Abelson made in *Science* recently: the insatiable appetite of our country for oil is a big incentive to the proliferation of nuclear technology elsewhere in the world.[7]

What kind of government actions, particularly in the research area, will lead to an increase in public acceptability of nuclear power? The willingness to maintain an open mind about the technical and economic viability of various technologies is very, very important. I do not think anyone has seriously proposed nuclear power as a panacea, but the public believes that within the government there are people who have made such proposals and who believe that to be the case. Therefore, it is important that the government as well as the private sector aggressively pursue a wide range of technologies, not only because it is the right thing to

[7]Philip H. Abelson, "Oil and the World's Future," editorial, Science, 194:4266:681.

do, but because it will, I think, also have the beneficial side effect of increasing confidence in those technologies that do enter the marketplace.

Within nuclear power itself, it may be too early to make a commitment to the uranium-plutonium cycle. At least at the research and development level, we should continue with the thorium-uranium-233 work. Have we really taken a look at the various fuel cycle and reactor options: HTGR [high temperature gas reactor], heavy water moderated, and so on?

Finally, I want to make one other point relating to public acceptance. An assessment of the forces that have been employed or arrayed against nuclear power should be made; there are many motivations. I agree with Mason Willrich's suggestion that many of them have actually performed a public service by raising important questions. On the other hand, we also must recognize that today there is a basic antitechnology movement. The public acceptability of nuclear energy will be affected as other technologies are impacted—particularly regulated technologies. If there is a failure in the enforcement of regulations applying to drugs, that in some way will affect nuclear energy. People are suspicious of technology, and particularly of those where there is an important governmental regulatory function. There are concerns about collusion between the regulators and the industry and about the question of who should be trusted.

Charles J. Hitch

When I first saw Alvin Weinberg's plan, my reactions were that it was a very creditable attempt to meet some of the objections of the antinuclear people and certainly worth further exploration and development. But I also felt that it did not meet, in fact did not even address, my greatest concern about nuclear energy—its possible contribution to proliferation.

I thought it had a curious, static-like quality; it seemed as if we could decide the most economical, clean, and safe way to provide energy for the next 1000 years and put the facilities in place and turn them over to caretakers and keep moving. The world does not

work that way; certainly, the American economy never has. I personally hope for and expect all kinds of unpredictable, dynamic developments during the next 1000 years—and, indeed, during the next 25 years.

I think we are just too ignorant about the future economics of alternative energy sources, about their safety, about carcinogens, and about climatic effects—to mention a few—to make semipermanent choices and commitments. I think there is a good chance that if we built Alvin Weinberg's 1000 breeders in 100 parks tha they might look like 1000 dinosaurs before we got very far into the next millennium. And finally, I felt that he has set his sights too high in trying to find a plan acceptable to the committed nuclear antagonists. That is not possible; nor do I think it is necessary, perhaps not even desirable. I worry when we approach unanimity on almost anything in this country.

After reviewing the comments that we made about the plan [for this meeting], my feelings are that they have raised some serious technical questions, which we have discussed a little. For example, we have talked about whether it is desirable to collocate generating and reprocessing facilities and whether the pattern of the location of industry is compatible with the 100 large parks concept.

I think the comments also confirm that we cannot win over the antinuclear community—at least not with this [nuclear plan]. They do not like the social isolation concept or the elite cadre concept. What is striking to me is that the pronuclear forces do not like these either.

Perhaps we have to go back to square zero and ask What are the criteria for an acceptable nuclear plan? I would prefer to rephrase it as "an acceptable energy plan," since I believe that all the possible sources have to pass similar tests. I would like to go back still farther and ask what the energy problem is. Then the criteria will fold out.

The problem is that we are facing the necessity for a transition from oil and natural gas to energy sources that threaten to be more expensive, dirtier, and far more dangerous—or some combination of all three. We have

had other energy transitions in the past 200 years, but they have been pleasant transitions. They have always been to cheaper energy sources, and usually they have been to cleaner and more convenient sources. This transition is different. It promises to be painful.

The main criterion must be the minimization of some function of economic cost, dirt, and danger. And here we immediately confront a conflict in values, one which is probably unresolvable in any generally acceptable way. A lot of growth-oriented people—and I expect they are a majority of the population—want to assign the greatest weight to minimizing economic cost. They think that growth, high income, and jobs are worth a lot of undesirable environmental side effects. Some people—not as many—are gravely offended by dirt, and naturally they hate coal. Many are concerned mainly about safety; they would eliminate the dangerous options before choosing the most economical among the rest. An important subset of these would accept normal risks, such as those associated with coal mining or incidents affecting an individual reactor, but would find intolerable significantly increasing the risk of catastrophic damage such as blowing up the world in a thermonuclear war resulting from proliferation. These people either want to rule out the nuclear option or be persuaded that there really need be no relation between nuclear energy and proliferation.

So drawing up acceptable criteria will not be easy. We have the conflict in values—what really matters and what weight should be attached to these different values. We have our ignorance about risks and about environmental effects, as well as about future economics; and we have the unpredictable dynamics of technology and of social attitudes. Under these circumstances, one of the criteria must be flexibility. We must have a plan that can be, and probably will be, adjusted frequently as we learn more. We have to keep our options open.

Discussion

Abrahamson

I want to comment on the antinuclear forces. In 1968, 1969, 1970, and 1971 it was a very small number

of people who were trying to raise issues. Basically, these people were neither pro- nor antinuclear but were simply skeptical; they were troubled by the gross discrepancies among available publications. But things have changed. Now the opposition is coming from a much broader and entirely different segment of the population. There is no leadership to the antinuclear movement; I think one can say that unequivocably.

Willrich

We are at a very interesting juncture at this meeting, and I would like to go back to what Charles Hitch has brought forward here. I would like to see if there is a conclusion we really have reached and upon which we can focus. Mr. Hitch has stated it in a nutshell, and falling out from that are precisely the reasons that explain why the antinuclear base has broadened and why those few who were simply skeptical and raised issues back in 1968 are essentially out of it.

The question I would like to raise at this point has to do with the issues of federal ownership and operation and the licensing of the fuel cycle facilities as a transition step that we have moved away from. We moved away from it in 1964, and now we might be beginning to move back toward it. A lot of people have suggested possibly focusing some discussion on that particular step, at this particular time, as something that might be compatible with either an eventual shutdown of the industry or an eventual evolution toward acceptable institutions for Phase II.

McCormack

In responding to the suggestion that I elaborate on government ownership, management, and control of the fuel cycle, I should preface my response by saying I do not want to be put in an advocacy position here. I am simply presenting an idea.

If we start with the facts that the federal government will handle the management of wastes, that there is a serious question about the economics of reprocessing, that we have the question of protection against diversion of materials, that we have the question of accountability, and that we have the question of ownership of enrichment facilities, then all of these are

focused on the question of whether or not we should have a federal corporation that would own all nuclear fuel—from yellow cake through waste—and simply contract for the various steps in the procedure with private industry, as it is appropriate.

I have not yet studied this idea at length, but I have seen studies on fuel enrichment. We know perfectly well that enrichment can be a very profitable venture. We know that fuel fabrication can also be a profitible venture. We know that there there is a serious question about the economics of handling reprocessing and that waste management simply is an expense.

Therefore, the question of a federal corporation comes up rather forcibly. This corporation would purchase yellow cake at established prices, enrich and fabricate fuel by contracting with private operators, lease the fuel to both domestic and foreign utilities, and take it back and reprocess it.

I believe that a federal corporation of this sort could easily be operated at a profit without doing violence to the economics of the utility system. I believe that we could easily make big money on this sort of thing. We could then finance all of the rest of the energy research and development programs that are undertaken.

This answers some of the questions about our relationships to foreign countries if we are perfectly willing to sell, lease, or give fuel elements to foreign countries to whom we sell nuclear power plants on condition that we get the fuel elements back and on condition that the elements are susceptible to IAEA [International Atomic Energy Agency] inspection. It is one answer to the proliferation question. It is also one answer to the question of diversion and accountability of the materials that are federally owned and to some of the more emotional questions that have come up in the Congress.

We must also remember that, in the atmosphere in which we are working, while there is an antinuclear constituency there is also a larger anti-big-business constituency that the antinuclear advocates are using as a weapon.

Ray Thornton, U.S. House of Representatives, Arkansas

Such a [federal] corporation could address the problems of capital formation and also the problems of satisfying public concerns about the confidence in the ownership and operation of such a facility.

With some help from Mike McCormack, I introduced at the first of the [94th Congressional] session a bill to provide for the construction of some 20 nuclear facilities, including, in some instances, integrated facilities from fabrication on through power production, but not including waste disposal. It did actually include onsite power production with those facilities being leased to the private sector—following the pattern of the industrial development of capital formation assistance that we provided in Arkansas in attracting industry to that state. The bill did get some favorable comment. Westinghouse looked at it as a possible mechanism for going to the floating power generating facilities that it was interested in. The important point is that it would add to public confidence in the security of nuclear power.

Mr. Hitch has really focused on the basis of opposition: the concern for safety and the fear of a catastrophic loss. The government's experience in operating and dealing with nuclear weapons and nuclear submarines is a strong argument in favor of the government's ability to handle these items without resultant damage or loss.

At some point I would like information about how much danger there is of a terrorist's getting nuclear weapons that are made outside the energy generating sector. It seems to me that there is a risk involving countries that do have nuclear technology. How are these weapons safeguarded? Can someone not go into a facility and get an operable weapon, instead of going to all the trouble of working on the very difficult problem of making a weapon from some of the side products of one of these nuclear plants?

LeGassie

What Mike McCormack just described was proposed in 1962; the Congress debated it for two years and then passed the Private Ownership Act of 1964 to give us the present system. Just because we are unhappy with the

status quo does not necessarily mean that we ought to lurch backwards to a situation we did not like when we had it.

Having made that negative remark, I nevertheless think that at the very core of this problem there is the following: As I have already said, although I am not labeled as a nuclear critic or accepted as one by those who are, I am personally convinced there are inadequacies in the present nuclear system, and particularly in some of the institutional aspects of the system.

Some of those inadequacies are true of energy systems generally and are not unique to nuclear. They are exactly in the area of Charles Hitch's remarks and have to do with the degree to which energy (nuclear energy in particular) is approached solely on the basis of marketplace views of the world as opposed to those views being broadened to include what I sometimes call "aspects of social responsibility," that is, adequate recognition of things that go beyond marketplace considerations, such as how the environment, growth, nuclear proliferation, or health and safety issues are dealt with. The concern is whether or not the existing institutions—whether they be governmental, private, or regulated monopolies such as utilities—have indicated to the public they adequately recognize their responsibilities in those areas as well as the historic areas of reliable delivery of cheap energy.

It has been agreed that the waste management element in the nuclear fuel cycle is so clearly affected with this aspect of public interest that it shall be the federal government's responsibility to conduct it. I think that is, at the moment, a settled matter. Perhaps, as Mason Willrich indicated, one of the yet missing elements of that determination is the establishment of a governmental entity, separate from a research and development organization, which is chartered with a management responsibility to address that operational activity.

The matter of whether reprocessing should be placed in the same category as waste management is indeed a topic for public discussion and, ultimately, for public decisionmaking—by that I mean Congress.

At the time of that debate, Congress must also deal with the question of whether or not President Ford's position of October 28th [1976] concerning the United States' position on reprocessing is indeed the appropriate one. The matter has not been subjected to wide public debate. Perhaps we inevitably get connected to the refabrication of the mixed oxide fuel for light water reactors if we take the step of a government framework for reprocessing. There has been agreement here about the sensibility of collocation of these two steps in the same physical territory, and, indeed, the technical integration of those activities would certainly be desirable.

However, I really question whether, if one then goes to the front end of the fuel cycle and looks at enrichment, there is indeed a similar problem. Laying aside the UEA [United Enrichment Associates]-Bechtel enrichment matter, which I think is clearly settled and which the world thought was a bad idea for many reasons, there is still the opportunity to support the establishment of a centrifuge enrichment industry that can be private. Companies are very nervous because of nuclear moritoria and everything else that would make it a bad business venture. But aside from that, I think there is agreement that the technological risks are within the capabilities of the companies involved. And in investment terms, the technology has reached a state where it can be commercialized.

It would seem to me that there is a strong case for proceeding with some government capacity on enrichment and of supporting the commercialization of centrifuge technology in industry—if industry is prepared to receive it and if the utilities believe that could be a reliable and economic source of supply. However, if they do not want to—and I think there is general agreement that this is a necessary activity in support of the fuel cycle—and if one needs capacity, then the government would have to view that as a commercialization failure.

Culler

There are uncertainties other than the technology of enrichment. The big uncertainty may be the availa-

bility of a market due to the uncertainty of the role that nuclear has because of the multiple choices that will be maintained in the utility industry.

Now, if the government's position were to turn out to be that we think we should keep the nuclear option open and maintain our ability to sell enriched reactors (with necessary safeguards) overseas, the guarantee of a fuel supply is important. I just returned from a Scientific Advisory Committee meeting of the IAEA, and the word there is that you cannot depend upon the United States as a fuel supplier. If we want to correct that condition, there have to be positive moves rather than the iterative uncertainty, but the moves must not commit us forever.

LeGassie

You must have completely misunderstood me. I said that I thought it was necessary for there to be a government enrichment capability, and the international requirement is one of the reasons. I was indicating my view that I saw no reason, in thinking downstream, why one should not think in terms of a private commercial enriching activity, since this is less clearly affected by the public issue problem of the latter part of the fuel cycle.

The point I would like to make is that I think there is a central institutional issue that has to do with acceptability to nuclear proponents who are not satisfied with the nuclear posture of institutions that deal with public interest questions such as proliferation and the environment. I think electric utilities should recognize more responsibility in their performance in these areas. Perhaps they need some further institutional superstructure or additions to the existing structures to make it clear to more people that they will, in fact, give nuclear the kind of special treatment inside their system that many people around this table have said is warranted.

Therefore, in terms of modifying the present system to increase its acceptability—and I do not mean in a public relations sense but in a sense of real comfort to people who are in the middle of the spectrum—the possibility of some governmental changes of an institutional character and some external changes of an institu-

tional character ought to be vigorously explored.

Benedict

I want to comment on Mike McCormack's suggestion of a government fuel corporation. The setting up of a government nuclear fuel corporation, if it excluded the nuclear power plant and left that in the hands of the organizations responsible for supplying electricity, would have the merit of being a clean, well-defined operation—all the way from uranium, which could be purchased on the commercial market, through the disposition of the fuel.

I think we will find that everyone at this meeting agrees that the waste management problem has to be a government activity and that reprocessing, with all of the uncertainties about licensing and safeguards and everything else, will probably also have to be a government responsibility. Whether this government corporation extends to the front end of the cycle requires more analysis. I will reserve until this afternoon's session my reasons for preferring to see that, to the maximum extent possible, it be in the private sector.

I would just like to ask Mike McCormack a few questions about the funding arrangement for this government fuel corporation. How would the plant investment and other head-end costs be funded? Would it be by an initial Congressional appropriation for the whole job right from the beginning, or would it be by the annual budget cycle? How would the subsequent operating costs be funded? How would the same kind of cost control be secured for a government monopoly that would be attainable through competition among multiple suppliers of the same service, such as we have now, in providing for nuclear fuel fabrication? How could we be sure we were getting the lowest possible cost? And, finally, with the government being in charge of the front end of the fuel cycle—especially fabrication—who would have the responsibility for the performance of the fuel in the reactors, such as the fuel fabricator now has?

McCormack

No Congress in the immediate future will pass legislation allowing private industry to enrich uranium. We must disenthrall ourselves from this concept. Last ses-

sion's House passage of the Uranium Enrichment Bill was a freak, parliamentary accident that will not recur.

Let me give you some off-the-cuff responses to your questions about financing. In the first place, we start off with some substantial capital assets in the form of the enrichment facilities. Secondly, it would be very easy to sell securities for such a corporation. Finally, I believe that once we start this operation it would be extremely lucrative. I have seen figures prepared by Clarence Larson [former AEC commissioner] on just the profits involved in enrichment alone; they run into many tens of billions of dollars in this century. I believe that the whole system could be operated at a profit once it was started.

If it is necessary to start it off with federal appropriations, then whatever is necessary to be done would be done. But very early on, it would be possible to sell securities for any substantial operation. I would simply preempt fabrication of fuel to the federal government and put it out for private bid among private contractors. The fuel would be the property of the federal government, and the responsibility for the fuel and for its performance would also be in the hands of the federal government.

Davis

It seems to me that we really would be going back to essentially the situation we had in the early days when, in fact, the fuel was owned by the government but the reactor manufacturers took the fuel allocated to the utility and fabricated it for use by the utility. It would seem to me that we would be able to find some way to have a similar arrangement now. Furthermore, if we got into collocation, it might not be unreasonable to at least consider that we would have a reprocessing plant and perhaps some satellite—privately owned and operated, but operating with government-owned fuel—fabrication facilities that might be run by whoever had that collocated plant under government control.

That would fit together and still give the reactor manufacturers and the utilities the kind of assurances they would like that the fuel being prepared is adaptable and has the proper performance in their reactors, even

though the fissionable material is owned by the government.

Swidler

Having worked for a government corporation for many years, I have a little experience with how difficult the problem can be. TVA has done and is still doing a very good job, but it has been pretty lucky in having been set up in a flexible way. Even at that, it has needed cooperation from Congress on a number of occasions when raising its borrowing limits.

I am sympathetic to the concept in general. I would like to stress the importance of thinking through the operating problems at the start and setting the idea on the right course. We cannot simply merge commercial and noncommercial operations and expect one to support the other, or we will get an animal that will be difficult to explain and will have results that cannot be rationalized.

There are a couple of special risks: It will be charged that the government is taking over all of the risk and all of the loss elements and turning over the profitable end of the business to utility companies. So, undoubtedly, it will engender pressure to take over the entire cycle, including reactor operation and perhaps the utility business. In that connection, I think one would get a lot of pressure for the public preference clause now found in all of the statutes relating to the operation of government power plants. And with that clause, of course, the ultimate demise of the private sector of the utility industry is only a question of time.

Perhaps that is something that should be planned for, but if it is not intended, then this should be taken into account in drafting the bill. It is necessary to hold out for the kind of specific financial standards that are expected in a business-like operation. Should they cover a return on the government's investment? Should it make a profit? Should it make tax equivalent payments to the states and counties? Should it make payments in lieu of taxes to the federal government for those operations that, if in private ownership, would produce tax revenues? All of these are the practical problems that hit a government corporation as soon as we begin to

develop a practical image of the agency.

Abrahamson

This discussion has not been directed toward what the impact of this public ownership would be on the broader acceptance of the nuclear enterprise. Do you think it would matter at all? Would it in any way affect the course and nature of the debate going on about atomic power?

McCormack

It is my understanding that the reactor vendors pride themselves on their individual designs of fuel elements. They consider their designs as partly proprietary and as one of the means by which they compete in selling their reactors. This is not an objection to your general plan, because I think the government could own the uranium that is contained in these fuel elements but still have that element of private competition in the production of the fuel assemblies that go into the reactors.

In general, I want to express my feeling that this is a very productive suggestion and that it opens the road to an assurance that the industry will need in the next step when they go into the breeder reactor. It will provide a mechanism that is very important in establishing breeders or closing the fuel cycle.

Cochran

First, I think government takeover of the fuel cycle is probably inevitable if we are going to try to push through the plutonium recycle industry and move toward the breeders. Congressman McCormack might be surprised where the chips fall regarding the environmentalist or antinuclear sentiments with respect to this proposal. A lot of people will just see this as an effort to subsidize the breeder program and as the first stage of government encroachment into the takeover of the entire nuclear fuel business, including the breeder reactors. I think we would find a lot of sentiment for maintaining the private sector in the fuel business.

McCracken

We have missed one criterion for an acceptable nuclear system in our discussion, and it is particularly relevant this morning as we talk about short-term issues.

Specifically, it is the criterion of a viable supplier industry. How can we keep our energy options open and ensure that there will be a viable supplier industry while we debate the various issues that are before us? Phase I is at a dead standstill. It is not only in its infancy, it is barely started in terms of having a viable supplier industry that could be self-supporting. Now, clearly and obviously, the suppliers have to survive Phase I if they are going to be around for Phase II, since the people who make the light water reactors will be the people who make the breeders.

I am afraid that we will debate so long we will suddenly stop talking because of this tremendous silence, and we will look around to find no industry around to be the supplier. That would be terribly wrong. Essentially, we will have dug in the industry by default. Time is, in fact, limited. Let me follow up on Tom Cochran's comment that the suppliers are living off their backlog. We are, but to say that we are living well off that backlog is wrong. In order for a supplier to responsibly deliver nuclear steam supply systems, he has to take a lot of time, spend a lot of money, and put together thousands of people over that long period of time. All of the suppliers have done that.

We also take contracts for nuclear steam supply systems. And while they have escalation clauses in them, there is essentially a fixed income involved with each. As things stop and as time draws out, we have to maintain that base of capability or we are being irresponsible to the future. And we are collecting the same amount of money despite escalating costs for many years.

How, then, do we maintain this supplier industry while we debate the options? We have said over the last couple of days that the immediate problems are not primarily technical; I agree with that. We have also noted, however, that in this period of transition we will have to listen to Mr. Carter while he gets his feet on the ground and does some things, such as reorganize—which he has the mandate and privilege of doing—or we may not get very far in terms of Congressional action. And I simply bring out the question: How much longer

can we survive as the debate continues? What specific things can we do, or can we urge to be done? I simply want to reemphasize that the near-term demonstration of waste management has to have the highest priority.

Secondly, in terms of the near future, we must stop pushing the technology of power plants beyond where our regulators feel comfortable. I am not saying we have pushed too far; there have been a lot of reasons for pushing them. But we simply have pushed technology beyond the place where regulators feel comfortable with it.

Every time a supplier comes in with a new reactor design, we wonder why it takes so long for the NRC to license it. It is something they have not seen before. And what we have to do is to step back and settle the technology at a level that has been proven reliable and that the NRC has seen before and feels comfortable with.

In summary, let us not be irresponsible planners and foreclose options by default. I am convinced that the price of being wrong is very, very high.

MacPherson

On waste disposal, there is one thing that does bother me a little: What can be done in time? We are faced with the problem right now. And presumably, the next two or three years are pretty important to suppliers. The full demonstration of waste disposal will not occur, no matter what anyone does, for a number of years.

McCracken

I should defer the answer of that to ERDA and the Congress. But it seems to me that one step can be more public knowledge of what the plan is and a better feeling of whether the public likes it or not.

Heath

All I can say is that the industry will have to help. ERDA had a public meeting in Chicago that lasted several days. There was a press conference last week in which Dick Roberts [ERDA assistant administrator for nuclear energy] said that they have been in communication with all of the governors and all of the Congressmen of the states affected by the program.

Articles have been published. I think the plan is no longer on the desks of the ERDA people. Now we need help disseminating the information.

Cochran

Mr. McCracken mentioned the near-term demonstration of waste management and that we should stop pushing the technology beyond where the regulators feel comfortable. He did not mention demonstrating plutonium recycle. Therefore, in getting back to number one on your list, would you be comfortable with a waste management program that had as its highest priority the demonstration of retrievable storage of spent fuel elements as opposed to going through the reprocessing steps? And would you see that as providing a quicker demonstration of some sort of waste management solution and as easing the debate over the preferred technology for the management of the waste and the back end of the fuel cycle?

Specifically, I am talking about putting waste in a geological formation in a retrievable manner—as spent fuel, as opposed to reprocessing and vitrification of the wastes. My position is that there is a lot of waste in the country right now, something must be done about it, and the preferred location is underground. Until I get some good argument otherwise, I would advocate not reprocessing—because of the proliferation problem—and I would advocate going to the burial of the spent fuel rods. And since one might want to redebate the breeder issue 25 years from now, one might want to do that in some sort of retrievable manner. I would not particularly object to that.

LeGassie

Actually, one can deal adequately with the proliferation issues of the light water reactor plutonium recycle economy and destroy the plutonium by consuming it in a reactor instead of putting it in the ground where it remains dangerous for 240,000 years.

So, on balance, if we lay the breeder aside and address the proliferation issue, I think all of the advantages are on the side of reprocessing and recycling plutonium. We can destroy it by using it in light water reactors.

I would say, in support of what Roger LeGassie has said, that the storage of spent fuel (without reprocessing) in geological formations is a much more severe threat to future generations than reprocessing and putting it in a stable and insoluble form in a much smaller volume. *Benedict*

I do not think it is in a smaller volume when you consider all the low-level and intermediate-level wastes. *Cochran*

I said yesterday that the primary reason for my attendance—representing the nuclear part of ERDA—was to get feedback, information, and ideas. And there are two very specific ideas in the short-term that have been introduced and that I think have tremendous impact on things ERDA has in its plans. Therefore, I would like to ask for further clarification of these. The first is the issue of federalization of the fuel cycle. *Heath*

I would summarize, in going back and talking to my boss, that the reaction to this proposal did not surface any significant opposition. Now certain segments represented here, particularly the utility people, have not really had a lot to say about that issue. So I would be interested in hearing from those people if there are segments that have not had an opportunity to speak this morning and really have difficulty with that idea. That is a very valuable piece of feedback I would like to have.

Let me qualify that. The support is for federalizing the back end of the fuel cycle only. *Benedict*

The second issue had to do with the internationalization of the breeder program. Now obviously at the present time, the breeder program is a very large and significant portion of the activity in nuclear energy. And I think that people in ERDA would be extremely interested in getting further amplification of ideas that people have in this regard. *Heath*

I am concerned with something that goes much farther and is much broader than the viability of the *Sporn*

supply industry. I am concerned with the viability of this nation. If we do not solve the energy crisis, we will have a very dim future because our present is so dim.

Secondly, we have talked about new institutions. I would like to call to your attention the fact that over the last 20 to 30 years, our experience with new institutions has not been a very happy one. For example, the new cities we have created are one of the great drains on the economy of this country. And there is hardly a single one that has had any kind of success. I think we have made an effort at building some 20 of them.

It is very important that we consider what we can do with existing institutions—not as they are, but as we can modify them, and improve them. It is much easier to bring about success in that way than to start with brand new ones.

With electric energy, we have had an experience of 95 years. Unquestionably the greatest job done in electric energy in any society on the face of this earth has been done in the United States. And if it had been natural to develop a power system covering the entire land area of the United States, it would have come about sometime during these 95 years. Instead we have had regional development, which is best exemplified today by the Regional Reliability Councils. For the centralized generation of nuclear power, what should be examined carefully is the concept of setting it up on the basis of the reliability councils and the regional systems.

Here I want to point out the importance of such a setup as against a single, gigantic enterprise. For anything that we need on a large scale—even nuclear energy—a regional system that is properly set up would be adequate. It would be large enough to set up a complete planning, design, and construction organization and would solve the problem of feedback between the people who build and use the plants and the people who conceive the equipment and then design and build it. On the other hand, it would not be large enough to create a monopoly, which is very bad whoever the owners.

Now, there is a very solid reason, I think, for the

difficulty that nuclear power finds itself in. Since the turn of the century, Western societies have witnessed a remarkable acceleration of technological progress. In general, this has had a disturbing effect—as any such acceleration has on individuals in society.

Both the individual and society are capable of absorbing only a finite amount of change per unit of time before the organism or system begins to experience difficulty. And their behavior, often interpreted as political, may be simply an attempt to bring clarity to an obscure, complex, and inadequately conceptualized (and, therefore, anxiety-provoking) condition. If you look at the tendency to arrest the development of nuclear power in the United States, Great Britain, France, Denmark, and Sweden, it can be explained as follows. It was not until several years after the Hiroshima and Nagasaki bombings that the public in the United States, Europe, and the rest of the world became fully aware of the immensity and enormity of this event. The period following this event and its relative acceptance was, in my judgment, but an interlude. In recent years, increasing interest in the prevalence of fears of nuclear war has reemerged. And when such pervasive fears disappear, it does not mean that they may not reappear at a later date.

The energy crisis of 1973 served also as a temporary catalyst to increasing public awareness of nuclear energy. In addition, it provided for the reemergence of the fears of nuclear war and nuclear weapons that may be less directly evident. It may be entirely possible that a significant part of the public concern regarding the perils of nuclear energy may represent anxiety displaced or translated into physical terms from the fear of nuclear war. The rush towards nuclear expansion also contributed to this lack of separation between the beneficial qualities of nuclear energy and the threat to man's extinction as a species posed by the atomic bomb.

We need to stop the present rush towards nuclear power; this might reassure people and it might make it easier to have the kind of expansion the country needs.

Session V

General Discussion and Summary

Davis

This workshop has been revealing and generally productive; we will all go away with some new thoughts and some new ideas.

I would like to make two observations regarding my opening comments of yesterday. When I talked about the nuclear industry, I did not say, nor did I imply, that it was complete or necessarily economic as a whole. I said only that it is there, it is quite large, it has momentum, and it cannot be ignored. Also, I commented on evolution. This was interpreted by some people, apparently, as "business as usual." That was not what I meant, nor is it what I said. I liked Mason Willrich's description of organic growth, which is perhaps much better than the thought I had in mind.

One of the key questions addressed by the workshop was: Is there some modification of the present system—in which I would include the technology, the siting, the licensing, the contractual arrangements, the ownership, the operation, and so forth—that for future reactor systems would satisfy the opponents of nuclear power? The few nuclear opponents who are here have been very frank and very clear in their opinion that for plutonium-fueled breeder reactors the answer is *No.* They have also been clear in saying that while they themselves would not necessarily support the idea, they feel complete abandonment of fuel reprocessing and,

hence, the plutonium-fueled breeder might gain support from some of the nuclear opponents.

A further element of disagreement is that the nuclear opponents believe that no significant addition to power generation is necessary, regardless of the source, if proper attention is given to conservation measures.

I am convinced that there is considerable support for the concept that the present system, as I have described it, can be strengthened and improved and can organically grow to accommodate the introduction of breeders when required without the need for some abrupt discontinuity or wholly new approach. Nuclear energy always has been considered special and should be considered special in the future, but it can grow in an orderly way.

On a very positive note, there seems to be general agreement that the collocation of chemical reprocessing and plutonium fuel fabrication is desirable and should be implemented to minimize the possibility of diversion. However, there seems to be general disagreement about the proposition that reactors—light water or breeder reactors—need to be collocated with reprocessing and fabrication plants. Also, while facilities for waste solidification would naturally be a part of the reprocessing-fabrication facility, it seems likely and acceptable that the waste disposal sites might be at a different and remote location, which would not likely be a practical one for the reprocessing and fabrication facility.

The sense that I get, at least at the present, seems to be that in addition to collocation of the reprocessing and fabrication plants, the government should own and control the reprocessing and waste disposal facilities. This is, of course, what Mike McCormack has said. However, it would seem desirable to provide competition for the fabrication plants. These might be privately owned and operated, although under strict control of the government, at common sites with reprocessing facilities.

On the front end of the fuel cycle, the consensus seems to be that uranium mining should be a part of the private sector. And although we did not mention it, I

would assume that this might also include the conversion to uranium hexafluoride, which is presently partly in the private sector. There seems to be general agreement that added enrichment capacity must be provided by the government. Of course, that would suggest that private initiatives still seem possible and may be particularly important in providing for international demands.

Another conclusion that I reached from the meeting is that the proposition put forth by Alvin Weinberg for government ownership and operation of nuclear power plants seems to be generally unacceptable either now or in the future, especially if it is coupled with the notion of a paramilitary-like organization. Charles Hitch's comment was particularly appropriate in this respect.

There also seems to be little support for the idea that international proliferation will be reduced by the United States' foregoing reprocessing and the breeder. And, indeed, it has been suggested—and I would certainly concur and have said so in other forums—that the withdrawal of the United States from such operations, and particularly from the international trade aspects of nuclear power as a consequence, will weaken U. S. influence in international matters and will actually lead to increased proliferation. In addition, although it is difficult to prove it, the consequences of the course that we are on now, much less an accentuated one, will be that our role on the international scene and in international nuclear activities will decline further.

These are the conclusions I have come to from our two days of discussion.

Weinberg

We had a meeting of four of the IEA people at lunch to try to arrive at a summary of what went on. Many of the items that you mentioned were on our list, too, and of essentially the same cast.

Rossin

I have the impression that wars very seldom start as a result of the availability of a weapon. They are much more likely to stem from very serious social, economic, or basic political problems. Isn't the lack of availability of energy and the feeling that oil prices may be beyond what countries can afford rather serious provocation?

Davis

I think this is a very important element. One of the issues that I feel very strongly about is, in fact, one that many people raised five years ago—long before OPEC raised prices. This was the concern that by about 1990 the production of oil in the world would have flattened out—as it did in this country in 1970—and we would then be competing with other industrialized as well as emerging nations for what would by then be in very limited supply. There is a serious hazard of international conflict on a global scale, possibly a nuclear scale, if we do not resolve the energy situation—and if we do not resolve it within the next 10 or 15 years.

Cooper

This is an important point. This question is so complex that there are no experts. We have to be very careful, especially in a discussion of technology, in making broad generalizations about such issues. My own feeling is that proliferation of weapons is more a matter for the Secretary of State and the President to grapple with in international forums where they are dealing with treaties and other arrangements.

Weinberg

I want to intervene at this point and say that I do not think that the issue, which is of course extremely important and very interesting, is fully germane to the topic of this conference. Dave Rossin was pointing out that there is a great need for a means of producing our energy. In a sense, that changes the criteria by which we would determine whether a given means of producing energy was acceptable.

Edward Schmidt, Private Consultant

[Karl von] Clausewitz said that war is an extension of foreign policy by other means. I would like to suggest that energy policy is an extension of ideological warfare by other means. People say the problems are not technical, that they are socioeconomic. I used to think the problems were metaphysical, but now I go a step further and say they are ideological. What we have done is to surface all of our ideological problems, and energy policy is just the vehicle for debating them.

It is interesting that when we used to debate ideology or theology or metaphysics, our ultimate appeal

would be to the Lord. We would say, "As the Lord is my judge . . . ." In this newer framework, the Lord has disappeared and each of us makes his ultimate appeal to the "informed public." If the public votes against us or expresses an opinion against us, we retreat to a position that says, "Well, the public wasn't informed on this issue."

Unfortunately, I am old enough to remember much of prohibition and repeal. So the "informed public" can swing 180 degrees in a 13-year period on an issue so simple as alcohol. And if they will do that, I am absolutely confident that there can never be a final decision on a more complicated subject of human process and material. So I would suggest that neither side take very much comfort in a simple majority or a final vote.

How did we get here? At the risk of a violent simplification, I would say that we got here when Admiral [H. G.] Rickover brought the submarine reactor up on land; that led to light water reactors. And if you have light water reactors, then you need Liquid Metal Fast Breeder Reactors later. And if you have LMFBRs, then you need plutonium forever.

I have often praised Admiral Rickover for developing the pressurized water reactor for submarines; it was a brilliant undertaking. But it is not clear to me that the pressurized water reactor is the right reactor for producing electricity.

I would direct my next comment to the scientists and engineers in this audience. I think they are a little bit remiss in not reexamining that fundamental technical program that we are on: Is light water reactor now/fast breeder later/plutonium forever the best of all possible systems to make electricity? I have tried this question on many of my friends and usually they say, "But we are so far into it and so much money is invested, etc., that we have to go ahead with it."

I do not think that is the real reason for their rejection. I think that down in their hearts, each and every one of them knows that it is not the best system. But to consider any other system requires such an incredible amount of intellectual energy—to go back and rethink what we have been doing for one, two, three, and in

some cases, four decades—that the intellectual energy threshold is just too large for them to get over.

Now, the subject of this meeting was "criteria." For many years I have tried to develop what I call the "Ten Commandments of Nuclear Energy." I am not going to list these Ten Commandments here, but for anybody who wants to come and talk to me, I would be happy to spend all the time anybody wants to spend. I would say the First Commandment is *Safety first.* This is because of the metaphysical and theological basis that underlies the whole argument. Without this First Commandment, I fear that we are just going to get into deeper and deeper trouble.

What do I mean by *Safety first?* I guess one of my definitions would be as follows: Design and build a system in such a way so that if all of the engineered safeguards failed, we would not and could not have a large, irreversible accident that covered a considerable amount of area. We design a system that, by the laws of nature and physics and everything we know, precludes a large, irreversible accident.

If I could ask each of you to do one thing to try to help the country along—which we all have some burden to do—it would be to sit down and try to write a set of Ten Commandments for an atomic power system that the people of this country will accept.

Weinberg

Let me speak further in possible elaboration and focusing of Ed Schmidt's First Commandment. Earlier this morning, Jack Ohanian tossed on the table the following: The Reactor Safety Study number is 1 in 20,000 for a core meltdown.[1] He invited us to express our views as to whether, over 25,000 gigawatt-years, that is acceptable or not.

Now, that study says we will do much better than that. Do we have some estimates of how much better we are likely to do? Do we have any estimate of how much better we have to do? And I must say that I am

[1]United States Nuclear Regulatory Commission, Reactor Safety Study: **An Assessment of Accident Risks in U. S. Commercial Nuclear Power Plants,** October 1975, WASH-1400 (NUREG-75/014).

very disappointed that so many reactor and other experts here, as well as utility people, are unwilling to go into that issue.

Rossin

I think most of us in the room are familiar with what the [Reactor Safety] Study says. It says that we are going to design a system that has certain engineered safeguard features that are supposed to work. The design basis for the whole plant is that these features and their backups and the containment will serve to prevent a release that would affect the health and safety of the public. The study then tries to find out what the probability is that this system will fail to do what it is supposed to do.

I do not have blind faith in probability figures; I do not have blind faith in the design-basis accident concept. I do have an engineering faith in it. And on the basis of my studies, I am confident that the safety features will work. Therefore, it comes down to whether I believe this kind of study shows the risk is worth taking. I do, and I argue in favor of doing so, and support it. I think the debate depends on whether people will accept the judgment of individuals like me.

Weinberg

Do I understand you, then, to say that you are not uncomfortable with a core meltdown probability of the order of 1 in 25,000 gigawatt-years? You seem to be very reluctant to use quantities in this. But if I carry your argument to its quantitative basis, that is what you seem to say.

Rossin

I am comfortable with a system that, when analyzed as it was (on a very stringent basis), comes out with that probability. That gives me enough confidence that I can say I am willing to live with this system.

Weinberg

But isn't that almost the essence of the issue we are trying to grope with here? Does the public at large (and, indeed, the informed public) and does the political body sense this is the order of risk that is being taken in this particular matter? And is it prepared to take that?

Pasternak

I was one who was attempting to react to Jack Ohanian's challenge to respond to that 1 in 20,000 figure, and I could not. Since then, I have tried to quantify it and to put it into some other terms that might be a basis for the kind of comparison you are asking for.

If one considers a site with a cluster of three reactors for instance—and there is such a site in California and probably elsewhere—and if one assumes a 35-year life with that cluster, the 1 in 20,000 figure becomes 1 in about 190 for a meltdown at that site. So I think the real questions are these: What happens after the meltdown? What is the remaining course of the accident? How dependable is the containment system? What is the probability for a serious breach?

Weinberg

The 1 in 20,000, as you recall, was a meltdown of which one in four would cause what we call a "serious breach" and the other three would cause a breach that goes down into the ground.

Pasternak

I am trying to get some estimate for those who live within some radius of that particular cluster. And, at the same time, there is a necessity to make a comparison. Another figure given by the study is for deaths by automobile accidents: 1 in 4000 per person per year. That works out to be 1 in 62 over a lifetime, a much larger probability.

Then, there are the other kinds of disasters, which other people have mentioned and which are perhaps more closely related to the deployment of nuclear power. The one mentioned just a few minutes ago was the possibility of world conflict over the availability of resources.

In any case, two things are indicated. One is to try to bring the 20,000 number down lower if we can. The second is, if we are willing to accept this as a meltdown possibility, to improve the means of containing that meltdown.

Weinberg

I agree that an objective evaluation of this risk against other risks must be made. On the other hand,

I would insist that a massive meltdown of the sort contemplated in the Reactor Safety Study, even though it has essentially no offsite consequences, is still a very, very major thing.

It is a very major thing as far as the public's perception is concerned. It could well bankrupt a utility. It raises very serious questions about what we do after we have a meltdown. It is on this account that I, at least, have been casting about for ways of really taking the study seriously and figuring out, on the one hand, ways of reducing that 1 in 20,000 and, on the other hand, mitigating the consequences even further.

Sporn

Isn't your preoccupation and your concern about the inability to get people to respond to numerical commitments really based on something else? If you put this question to another person, he might say: "Dr. Weinberg, I am not very good at these numbers. I want you to tell me whether there is any possibility of an accident occuring that will completely obliterate me."

And you say, "Honestly, I must say there is. But the probability is very, very low. But it could happen."

"That is all I wanted to know," he says.

We have not been able to answer this. This is the ultimate accident that we are all talking about. The low probability is something that could go from one extreme to another—low probability, but still a possibility; and that will never be altered.

Weinberg

That is correct. In my mind, that comes to the heart of what we were supposed to be discussing over these two days: practical, intelligent, reasonable, and achievable ways we can reduce that probability as far as possible.

LeGassie

To a degree, in places where moratorium votes have occurred, these kinds of matters have been discussed in public forums. Therefore, I think that you have got a kind of an answer.

This discussion to me seems to be a little bit of a side discussion. I think where it really gets you—to the extent that I read the public mood—is the kind of response that says, "All right, we understand the answer

to those. It is not very probable. And that is fine because we are perceiving the thing to have some benefits. But what we are turned on by is that all of that depends upon the fact that institutions function well; and when we look around, we do not see institutions functioning well. We do not see the Atomic Energy Commission historically functioning well, and we have lots of problems with that local public utility because they are raising rates and ripping us off. We are not sure that the NRC is functioning well because people are resigning. Waste tanks are leaking at Hanford; so ERDA is not functioning well."

So I think that rather than sit there and dwell on this number, we must go back to our earlier discussions of whether or not there are institutional and procedural modifications that are of an evolutionary character and that can be made to the present system so we can say the institutions are viable and functioning well.

Weinberg

This brings into focus one of the central issues of this workshop: We ought to examine the present institutional frameworks to see if they can also give us factors of 10—or maybe 100 or even more—improvement in safety.

Benedict

First of all, I would like to compliment Alvin Weinberg on bringing together people of diverse views, on having a good and frank airing of divergent opinions, and on reaching at least a partial consensus on some of the directions in which we ought to be going.

I would also like to say that I subscribe very closely to the remarks Ken Davis made a while ago. I will confine most of my comments to a personal examination of the steps in the nuclear fuel cycle—a small-scale examination of ways to continue to obtain the benefits of nuclear energy by putting it on a more financially sound and administratively acceptable basis. The system I will advocate differs slightly from Mike McCormack's. But at the same time, I do not want to undercut his general recommendation because I think it is important that we have some way of getting on, in an orderly way, with all the steps in the fuel cycle.

It ought to be important that this group recognize that the United States was once way ahead of the rest of the world in all parts of the nuclear fuel cycle. We ran the first breeder 25 years ago; we had the first and best enrichment plants in the world; and we had the first, the best, and the most versatile reprocessing plants. Now, because of a lack of a clear government policy as to how these are to be allocated between the government and the private sector, the lead in nuclear power systems is rapidly shifting to France, England, and Germany. Our opportunity for influencing foreign policy in the nuclear field is evaporating along with our business in the field. Our ability to use nuclear energy domestically to make up the shortfall in other energy sources is also drastically restricted.

I am really distressed by the fact that we have been on dead center with many of the decisions we have been discussing here and in the past year. And I hope that the next [Carter] administration and the next Congress will get us off dead center one way or another. It is more important to get off dead center than to do it in the specific way I will recommend.

We need a clear recognition that nuclear energy is an essential component in supplying future U. S. energy needs—not just an alternate, but an essential component. We need more nuclear energy, not less. And we need it for a long time, longer than the present uranium resources will serve us in nonbreeding reactors. In other words, we need a clear recognition that the breeder will be a central part of our energy system in the not too distant future. We need clear, stable government policy as to the institutional arrangements under which nuclear energy will be supplied. We cannot have it changing every four years when the administration changes. We need to know who will own and operate the fuel fabrication plants, enrichment plants, nuclear power plants, reprocessing plants, and waste management facilities.

My personal conviction is that the front end of the fuel cycle can and should be the responsibility of private industry to the maximum extent possible and that the back end of the fuel cycle should be the responsibility

of the government because of the risks in handling concentrated plutonium and the long-term responsibility of storing wastes. The front end, especially if undiluted fissile material is not handled here, can be dealt with securely by private industry.

One of the few things on which this group seems unanimous is one to which I subscribe whole heartedly—the collocation of reprocessing and fabrication plants should be required, and shipment of plutonium or highly enriched uranium in its undiluted form should be prohibited. To elaborate, starting at the front end of the fuel cycle, uranium mining and concentration is and should remain in private hands. The same is true of the conversion of concentrates to uranium hexafluoride. And I do not think anyone seriously questions these premises.

When we come to enrichment, there now seems to be no agreement. It is clear, however, that the biggest problem is raising the large amounts of capital for the needed additional capacity. The government will have difficulty insuring continuity in securing successive annual appropriations from Congress. And private industry has been experiencing difficulty in securing construction funds from commercial sources.

Here, I believe our policy should be to invite and encourage the involvement of private industry and the use of government facilities only to the extent needed to supplement and back up private enrichment ventures. But in the way things are going, I am afraid the government will have to do it. If the government does step in, it certainly ought to be done in some way that does not require annual appropriations from Congress; the need is just too great to have to risk successive annual appropriations.

Fuel fabrication has been, and should continue to be, a private venture. Competition among private suppliers will provide lower costs, better performance in reactors, and certainly better service in case the fuel fails to perform as well as desired.

Concern about security in handling plutonium in undiluted form can be dealt with by having plutonium leave the reprocessing plant diluted with uranium. And

certainly if there is collocation of reprocessing and fabrication at the same plant, the transfer of plutonium could be in the form of a liquid solution of mixed uranium and plutonium so that the fabricator would have maximum flexibility in the subsequent fabrication operations.

Next, let me turn to the nuclear power reactors—either converters or breeders. I would like to see them continue to be owned and operated by the companies generating and selling electricity. These companies should have the full responsibility for getting the plants licensed and for the consequences of operating them (including liability for accidents), and they should have up to the maximum amount of liability insurance that can be provided through private and government sources.

Collocation of reactors and fuel cycle facilities places intolerable restrictions on where reactors can be located because reprocessing plants have very special siting requirements. Reprocessing of commercial fuel should be demonstrated so that the costs of reprocessing can be determined and the uncertainties about licensing requirements and their effects on costs resolved. It is most unfortunate that the Ford announcement of last October delayed this—or even made it impossible—for an indefinite period. Under these conditions, it is impossible for private firms to risk building and owning reprocessing plants. The government will have to and should do it.

Fissile material coming from reprocessing plants and recycled to light water reactors is a valuable national resource. It is a pity to have it buried as unreprocessed fuel. It would increase the amount of electricity that could be generated from a given natural uranium resource base by 35 percent to 40 percent. It would restrain increases in uranium prices. And it would have an indirect economic benefit over and above the possibly marginal reduction in fuel cycle costs with fixed uranium prices, which has been cited as an argument against reprocessing. What is left out of that equation is the fact that if we do not reprocess, uranium prices will go up and our electricity will cost us more

than if we did reprocess. This indirect benefit from reprocessing was completely overlooked in the recent Presidential decision to defer commercial reprocessing. But of course with the breeder, reprocessing is absolutely necessary.

Everybody here is agreed that waste management must be a government responsibility because only the government has any probability of continuity for the long time spans over which waste must be managed. I also want to point out that the technology of dealing with the wastes safely by converting them into solid form and storing them in salt deposits is well established. We lack the institutional arrangements for getting on with the job and public acceptance of it.

To summarize, I advocate three things: First, leave the front end of the fuel cycle in the hands of private industry to the maximum extent possible—particularly 100 percent of uranium mining, uranium hexafluoride production, and fuel fabrication and enrichment to the extent that responsible and financially qualified producers are willing to enter the field. Second, leave the back end of the fuel cycle in government hands, with the government constructing and operating a full-scale reprocessing plant with established technology, to determine economics and to produce plutonium with the breeder. Third, where plutonium is used, either as recycle fuel for light water reactors or as a fuel for breeders, collocate plutonium fabrication and reprocessing plants and never ship plutonium in its pure form.

Selby

It is my feeling that in the long run the utilities will not be able to go through the process of establishing sites, using them, and then abandoning them—which is basically the way many things have been done in the past. If we take a look at the cost of a nuclear plant, the greater percentage of it is based in concrete and steel, which is really the passive structure of the system. Fundamentally, in my judgment, that should not wear out in 30 years.

We need to look into the future and think of sites as being permanent. Today we will have a light water

reactor in this containment vessel and structure, and it may be used for 40 years. We will expect the lifetime of the active operating part of the system to be designed so that, if possible, at the end of that time we do not decommission it; we replace those parts of the system that need to be replaced and continue operating.

Culler

Alvin Weinberg and I have talked about this. I do think that this is an important element in the new generation of thought. It is very much truer for possibly other parts of the fuel cycle; the canyons are more easily adapted than reactors.

I would like to tie it back to the question that Ed Schmidt raised about there being a possibility that we should go back and design the safest reactor possible, at least as a mental exercise, that would still produce electricity with reasonable efficiency and would follow the "safety first" rule. No one is quite willing to say that we will go back from the gerrymandered, add-on engineered safeguards and conceive another reactor that would include them more organically in the design. This would be a worthwhile exercise.

Weinberg

If you concede that there are these permanent sites at which this business is going to be handled, then you have achieved much of what you want to achieve—to confine heavily radioactive operations to a limited number of places. But you do not commit yourself, or you try hard not to commit yourself, to having almost any place committed to heavily radioactive operations. I suppose this is an example of an organic evolution into a mode that I, at least, think is a proper mode.

Benedict

That is a good point. This indefinite proliferation of sites for handling heavily radioactive material is a mistake. I think we ought to concentrate and centralize to the maximum extent that is economically and environmentally desirable. Except that, as I said earlier, the suggestion of concentrating enough nuclear power plants into a single site in order to make the reprocessing and waste management facilities there of an

economically large size is an undesirable concentration of power generating facilities on that site.

Cochran

Congressman McCormack, you mentioned that you are concerned about abuses with the NEPA [National Environmental Policy Act] process. And you have also mentioned federalizing the back end of the fuel cycle. What role would you see the NRC playing in such a federalization of reprocessing, etc., and what role would you see the NEPA process playing in that same regard?

McCormack

It seems to me that if one complies with the spirit of the law under NEPA, both generically for the system and specifically for any individual facility, without having unnecessary redundancy and without having harassing lawsuits, then you have met the criteria of NEPA and you have accomplished the goal of getting the process under way.

Cochran

Would impact statements be prepared on this program, and would these various subprograms be under NRC's regulatory control? Namely, would reprocessing still be licensed by the NRC? Would mixed-oxide facilities still be licensed even if they were government owned?

McCormack

I do not want to try to answer that question specifically today simply because I am not really sufficiently familiar with the procedures and requirements under NEPA to know what I am committing myself to.

The discussions of the past two days, along with the points and suggestions already made, have been very valuable. However, I fear it is always possible for us to lose sight of the major problems and, if I may use the cliché, not be able to see the forest for the trees. I recall having participated in a similar discussion 18 months ago; it was also two days. At that time we had a representative of the British government, an energy specialist, sitting in as a guest. After a couple of days of discussion, he was asked to make a comment. He said, "How can you possibly sit here like this and nitpick while the world is disintegrating before your eyes?"

Every passing day, Western civilization becomes more fragile and more vulnerable and more endangered. I think it is imperative for us to weigh everything we have been discussing in the context of the fact that this nation's entire civilization—standard of living, economic, political, societal stability—depends upon a prodigious consumption of energy, and we cannot change that quickly without sociological impacts that are totally unacceptable. And in spite of any conservative projections, we will still increase our consumption of energy by 50 percent to 100 percent during the balance of this century. We will do it while we are running out of petroleum and natural gas on which we depend for 75 percent of our energy. The stability of the free world depends upon this nation's continued strength. Therefore, we must have an integrated systems approach to a comprehensive national energy policy in which nuclear energy must play a major role.

So while these discussions are important and while they may lead us to solving some of the problems, I hope all of the discussions will be in the context of recognizing that we still must have the equivalent of 500 to 800 gigawatts (electric) nuclear capacity on line by the end of the century and that we must have a fuel cycle system to support them through the first half of the twenty-first century.

Thornton

I would like to join in the thought that we are faced with the depletion of finite energy resources. That is predictable and not disputed. For that reason, we will have to take steps to change a number of things in our society during a relatively short period of time. Among those would be a strong conservation effort, increased utilization of various alternative energy resources, and the utilization of nuclear energy because it is technologically feasible. Nuclear energy is ready to come on the line, it is useful economically and scientifically, and it has fewer environmental complications than some other alternatives that must also be used.

For these reasons, it seems to me that since we have a journey to make from what we are now using to the

energy resources we will have to have, the best function for a group such as this is to decide how best to move on with that journey so as not to have adverse impacts upon our environment and upon the quality of people's lives. Failure to do so can lead to an environmental catastrophy. If we wait until the time that our energy requirements have reached the stage of being allocated and priorities established as to who gets to use what energy to keep whose house warm, then we will undertake a crash program to develop resources withou paying any attention to any of the other important objectives that a number of us here around this table believe in.

I do not expect—nor did I expect—this group to come up with a consensus or a view upon which all of us would agree. It is very useful to present the polarized ideas of different people and to let us see what the problems are as perceived by people who do not view these matters from the same standpoint. And the function of the system of which George [Brown], Mike [McCormack], and I are members is to try to develop from these polarized ideas—which are articulated strongly by the advocates of different positions—a national policy that will recognize our country's need for an energy policy in future years.

Brown

The three of us here from the House [of Representatives] have three different points of view. On some occasions, we differ rather strongly. There are many things on which Mike [McCormack] and I disagree with regard to energy policy. And yet, we find that we have a cooperative and productive working relationship because we recognize that there are certain commonalities toward which we can work, whether or not we agree on many other points of view.

I am inclined to be sympathetic to the point of view that we do not need as much energy as we use. There are many exponents of this point of view. The more extreme ones, such as Amory Lovins, think we can move into the next era of human culture without nuclear energy—or oil or gas or coal. I basically sympathize

with this position and hope that it is true, but I am highly skeptical.

On the other hand, I am equally skeptical of the views of the stauncher proponents of nuclear energy who think the world will come crumbling down around our heads if we do not proceed full speed ahead with the development of a nuclear economy, and particularly a plutonium economy. And yet, there are many areas in which I can agree with the staunchest proponents of the nuclear option in seeking to develop a coherent and logical energy policy.

We must have a rational policy to solve obvious problems as quickly as possible and we must have reasonable regulatory procedures. I am willing to work as diligently as possible toward the solution of these problems; and this will aid the industry. On the other hand, I would like to see the industry and those who do not agree with me give some support to the idea that it is important that we think in terms of conservation, that we develop as rapidly as is technologically possible the benign forms of energy supply, that we think in terms of alternative ways of organizing energy systems, and that we take various other steps.

It is a tribute to Mike [McCormack] and to Ray [Thornton] that they have been able to agree to follow the latter path. There is no one who is more diligent than Mike, for example, in promoting solar and geothermal energy and some of the other ideas and in trying to secure a proper balance in the technological capabilities of this country. I would hope that the nuclear industry and the utility industry would be equally conscientious. I see signs that they are beginning to get that message.

Basically, the environment in which we are working here is much bigger than just the nuclear thing. It is even larger than just the question of energy. And we will be able to make only sound decisions in the nuclear field if we put these decisions into the broader context within which we are working. There are important questions about the proper roles of public and private industry that, for example, have made it difficult to solve

other aspects of nuclear policy. An example is the synthetic fuels development program. There are real problems with regard to public participation and public acceptance of nuclear energy. These problems, in my opinion, will only be resolved as a result of a much broader process of education of the public than we have at the present time.

I do not have this mystical fear of nuclear energy that many people have. An analysis of the numbers shows that the nuclear energy industry has an enviable safety and accident record, whereas other forms of energy utilization, broadly interpreted, are probably responsible—particularly if you want to throw automobiles in—for 100,000 deaths and $20 billion in costs per year to society. Nuclear energy could never achieve this—even under the worst of circumstances. But the public as a whole is more afraid of one accidental death [due to nuclear energy] than they are of 50,000 automobile deaths. That will only be resolved through a process of growing understanding.

I mentioned yesterday that the policy-making environment in Congress will change drastically on nuclear energy in the next year or two and that we have to be cognizant of the need to conduct a process right within the Congress of educating people to the facts of nuclear energy. When we do that, then we can address the basic policy questions that center around certain concepts of growth and what we really need in the way of energy in this society.

I think we have adopted too much on faith the idea that constant and increasingly rapid growth is the natural condition of modern man. And in a large sense, the opponents of nuclear energy, particularly the opponents of rapid nuclear development, reject that thesis. I am inclined to feel that they are more correct than those who see the rate of growth as constantly increasing. There are very few rates of growth that continue indefinitely. One of the few that I know of is not in the realm of human population or human technology or use of energy. It is the increase in the accretion of culture by the human race, which, fortunately, does not have too many bad environmental side effects.

It is quite likely that the use of energy, materials, population growth rates, and all of the other things we are indexed to are at a point of inflection on a very long curve. We do not know what the new direction of that curve will be. I very strongly support Mr. Sporn's thesis that perhaps part of our problem is the sheer and too rapid change in some of these important aspects of human development. Perhaps we ought to stand back and see if we can slow the process a little so that we really know where we are going in the next 50 or 100 years.

Rossin

Rather than a mad rush, I think we have a stagnation. I believe very strongly that we must differentiate between rushing to get into a plutonium economy and establishing barriers that make it impossible to move at all.

Secondly, some people at this workshop have said that the utilities are madly pushing for growth. When it costs us more to build the next increment of capacity than it cost us to build the last one, what is the great incentive if we charge the same amount for each hunk of electricity? Utilities are struggling to provide the facilities to meet their commitments; there is a very big difference between this and the implication that the utilities are madly pushing to build anything they can.

Finally, I would like to mention solar energy. I cannot think of a better fit if we can possibly make solar energy pay off. It has a good chance of leveling off some of the load peaks. The industry is very, very interested in trying to integrate solar energy with sound and viable electrical systems.

Cooper

I have Ten Commandments developed on the basis of the discussion that I have heard during the last day or so. These are the Ten Commandments for an Acceptable Nuclear Energy System:

1. Minimal (none, if possible) risk of major accidents.
2. Minimal (none, if possible) risk of diversion or theft.
3. Minimal risk to future generations. (And I am talking about things such as waste control.)

4. Economical (not necessarily cheap) costs.
5. It has to be part of a national strategic plan in general and a national energy plan in particular.
6. It has to be reliable in terms of operation.
7. It has to be regulable.
8. It has to be accountable to its customers and the public.
9. It has to have minimal hazards to air, water, and scenic amenities in its operation.
10. One has to be able to turn it around or turn it off in terms of individual plants or the whole system.

LeGassie

I have a preamble and a point. The preamble goes back to Dean Abrahamson's remark about why we are here. To some degree, my version of why I am here goes as follows: by listening to nuclear critics as well as to nuclear friends, to identify the remaining deficiencies that must be rectified to maximize the acceptability of the system. These deficiencies would be targets for action, but we must recognize that we live in a pluralistic society.

At the end of the workshop, I would like to state it much more strongly, and perhaps more positively. I am now convinced that the real task at hand is to address the issue of public acceptability, recognizing the pluralistic nature of this society, in terms of those in the center of the problem, including people such as myself who believe that there are things that still need to be done but who also believe that on balance we are going in the right direction. There may be some future question as to why we met and what we tried to do here. And it may be desirable to get that view on the record. That is the preamble.

The point is this: The workshop did develop a list of items that must be satisfactorily resolved if the downstream system is to be viable. Whether we are talking about how to get enrichment plants built or whether we really see our way clear to handling the proliferation problem, in many cases there are views that these things can be taken care of. But there are a variety of ways in which they might be done; it is getting to be time for us

to collectively settle on some consensus as to how we see these matters should be handled. Then we can define a system that, while not necessarily optimum, we believe to be workable and that addresses the issues and represents a way to proceed. If we do that, we might some day have a Phase II to talk about. If we do not, we may have lost a major opportunity.

Therefore, it is important to get to the follow-up processes. The meeting evidenced that there are many decisions that have yet to be made in the sense of a decision that is collectively arrived at and stable and agreed upon by the broad spectrum of participants. Many of those decisions may get made in Congress; some may get made in the President's office. But they will have to be made. And if it is true that we cannot stand another three or four years of this kind of uncertainty as to how we are going to proceed and still expect an industry to be out there when we finally get it settled, then perhaps this is the year in which we must make some real progress in settling those issues.

Therefore, I come now to two thoughts. One is that when we leave this meeting, it behooves each of us as individuals, on the one hand, and as representatives of institutions on the other, to initiate some further effort—institutionally and individually—to think further through the problems that have been identified and the possible responses and to develop well thought-out positions on these matters.

I really think we have to get to the point where we have thought a matter through and not depend on others to make the decisions without our input (I mean "our" collectively and on behalf of the institutions we represent). I want to stress my view that this is a year in which some decisions will be made. We had better get all of us who are affected by these decisions to give some thought as to what the right decision is and get our views organized and be prepared to insert them into the system.

In many cases it may not be important to have the ultimate description of the answer if we can at least have a description of a process that is credible and gets to the answer. In other words, if we could be sure that

steps were being taken to verify NRC's existence as a reliable and credible regulator of safety issues, then we do not have to answer in detail the question of whether or not some particular facet of the reactor design represents the right safety answer. We have an institutional answer: A credible institution exists to take care of that problem. Therefore, there has to be a distinction between ultimate answers and either procedural or institutional answers that can be satisfying and credible.

Weinberg

In concluding this session, I would go back to the list of 16 key issues that was in your booklet [Appendix B].

At lunch, Chet Cooper, Alan Poole [of IEA], Jack Ohanian, and I went over these 16 issues and tried to decide how many of them had been discussed, on how many of them we had achieved agreement, how many of them were avoided, and whether there were any real conclusions we could draw.

The fact is that we covered, a bit implicitly to be sure, almost all of the issues. And on a good number of them, quite surprisingly, we came to a consensual agreement.

For example, number 5: siting/collocation of reprocessing/fuel fabrication/waste management facilities; advantages/disadvantages of such centers; security implications. On the whole, we came out with rather few who said they disagreed with the proposition that if we have nuclear energy, then collocated fuel and refabrication facilities are a good idea.

Number 7: advantages/disadvantages of government ownership of generation end of the back end of the fuel cycle. We had Mike's [McCormack] proposal that many people described as being very interesting and worthy of much further study.

We looked at the question of the viability of Phase I. Here, of course, not all would agree that they want to make Phase I viable. That is perhaps putting it a little too strongly, but we did identify the uranium supply as being very important and that standardization would be a good move. We made the point that we should not be escalating the size of these plants too rapidly. This is the point that Bob McCracken brought out.

We have to get on, one way or another, with resolving the question of military wastes and the whole issue of the regulation and demonstration of waste management.

I will not go down all of the list because I think many of these issues have been covered already by well thought-through summaries—partial summaries given by Manson Benedict, Ken Davis, George Brown, and some of the others. I will point out that we did bring up a few points that had not really been anticipated in the original agenda. The question of the internationalization of the breeder project is an important matter that I think ought to be looked at seriously. It does relate in some degree to item 16 [see Appendix B]. Also, we did not speak to the issue of public participation in this list. However, we did refer to it many times during the course of the meeting. And in the course of the final remarks made by Roger LeGassie, this emerged as an important matter.

There is also the following aspect: How do we in fact arrive at what is an acceptable degree of public participation and how do we legitimize this? I think that is perhaps the essence of the issue. And this is a slightly different issue than the question of public acceptability.

One of the most telling points, I think, was the one brought up by George Brown. He pointed out, if I understood the force of his comments, that the difficulties with regulation arise because there is no underlying consensus with respect to the thing that is being regulated. The thing that is being regulated is not part of an understood, overall strategy. If we can get over that hurdle and if we can somehow get a consensus as to what the overall energy strategy is on the one hand, and what the domain of acceptability of nuclear energy within that overall strategy is on the other, then many of the difficulties that Joe Swidler exposed so very succinctly and knowledgeably with respect to the regulatory process could perhaps be much less difficult.

We have what I suppose we could call a common-law acceptance of the idea that airplanes are a good idea. Therefore, they do not really get into the same hassles

with the Federal Aviation Administration—or whoever the regulatory body is for airplanes—as nuclear energy does. And it is that underlying, common-law, consensual acceptance that we are somehow striving toward.

I would leave open the question of whether workshops of this sort are to be continued. We would be very pleased if the participants would write us with respect to their views on whether or not they think we ought to continue with this format.

I want to thank each of the participants, along with the staff, for this very interesting and, I hope, fruitful discussion.

Appendix A

Objectives and Outline of the Workshop

Our objective in bringing you together is to address the substantive issues in the nuclear debate and to try to define rational ways of resolution. Our basic premise is that nuclear energy is necessary for meeting the world's energy needs; therefore, the question is: How can the nuclear enterprise be made more acceptable?

The necessity to plan for an energy future in which nuclear power plays a key role results from the following:

1. An asymptotic world of about 2000 quads—in contrast to the present 230 quads—or even 1000 quads if the fossil option forecloses. An asymptotic U. S. future energy demand of 180 quads.
2. The possibility of a carbon dioxide catastrophe resulting from the burning of fossil fuels, especially coal.
3. Limits on the size of the solar energy system.
4. Limits on the amount of conservation.
5. Fusion not becoming a viable option.

Therefore, one must be prepared for a significantly enlarged nuclear energy system. We can argue about the exact dimensions of this asymptotic system, but the point is that a significantly larger system will be required. Our current guess is that of the 180 quads total, some 115 quads would be supplied by 1000 breeders, each rated at 2000 megawatts (electric). Whether or not this scenario in fact eventuates, prudence demands that

we do our best to plan for it, define the problems that must be resolved, and anticipate the limitations that may have to be imposed.

In many ways, the dilemmas and controversies we face today are the result of the rather rapid development of the present nuclear energy system without adequate long-range planning. Issues such as proliferation and waste management should have been resolved sooner; for various reasons, these did not receive sufficient priority and we are suddenly recognizing the consequences of some of these omissions. It is significant that the many questions that now trouble us were anticipated 30 years ago and resulted in the Acheson-Lilienthal plan for strict international control of *all* phases of nuclear energy. One way of phrasing a central issue of this workshop is the following: Should some version of the Baruch plan[1] be resurrected?

We must make sure that our future systems develop in a more systematic manner. In fact, the viability of the nuclear enterprise demands such an approach. This is the central premise of the workshop: *We must not only better understand the implications (i.e., new elements of uncertainty and/or risk that may be introduced) of large-scale nuclear power deployment but also adequately plan for it as we better understand the limitations of the system.*

Some have argued that this workshop is too late and that the polarization has sharpened to the extent that it is no longer possible to plan rationally for a reasonable and achievable system for the nearer- or even longer-term future and that the decisionmaking process has completely shifted to the public arena. To a significant extent, the latter has indeed happened, but we believe that such decisionmaking must depend on the enlightened and dispassionate guidance of the experts. We hope that this workshop and our overall study will provide such guidance.

As we examined the responses to the invitation to the workshop, we found that, despite seemingly ex-

[1]Statement made by Bernard M. Baruch, United States representative to the United Nations Atomic Energy Commission, on June 4, 1946.

tremely sharp divergences in viewpoint, there were some matters upon which there was considerable underlying agreement. The primary difference seems to be between those who believe in a natural evolution of the system and those who feel that more explicit planning is both feasible and desirable. Thus, almost all seem to agree, for example, that some collocation is desirable. There is disagreement as to the degree of collocation, but this is a technical question. The primary issue is whether collocation ought to be adopted now as a national policy or whether it ought to evolve as a natural outgrowth. Similar comments can be made with respect to the structure of the nuclear electricity industry. Philip Sporn, for example, seems to see strong advantage in regionalizing it, with an implied separation between generation and distribution. Should this become an explicitly articulated policy, or should this simply be allowed to develop naturally? Or again, should national energy centers be legislated or should they simply evolve? This range of issues will underlie much of our discussion: whether it is possible or useful to visualize now a long-range future and to try explicitly to bring it about or whether it is best to reduce such long-term planning to a minimum and allow natural evolution to follow its own course. As you know, our own feeling is that natural evolution without visualizing the full implication of the course we may be following has not been notably successful. However, others at this workshop hold different views, and these will be expressed during the sessions.

Our thinking about the shape of a long-range nuclear system has crystallized around the belief that nuclear energy will unfold in two phases. The first, designated as Phase I, is based on burner reactors and is limited by the amount of reasonably low-cost uranium that is available. We estimate this phase to last for perhaps 25,000 gigawatt-years, although this number depends both on the amount of uranium we find and on the degree to which fuel is recycled.

Phase I will ultimately give way to Phase II. If nuclear energy is to remain an option, Phase II will depend on breeders—most probably Liquid Metal

Fast Breeder Reactors—but conceivably other types, including, in principle, electric breeders. Our basic contention is that because Phase II may last an extremely long time, the criteria for acceptability that have been developed, somewhat implicitly, for the much shorter Phase I may not be adequate for the much longer Phase II.

We have structured our workshop to conform to these perceptions of the nuclear future. We shall have five separate sessions as designated on the program. Here we shall give a few words indicating what issues we think ought to be addressed in each session.

I. General Issues

The discussion ought first to bring out the basic difference in viewpoint between those who believe that nuclear enterprise, as is, is acceptable, and those who believe it is, in its present form, unacceptable. We have not invited anyone to the conference who believes that nuclear energy under no circumstances is acceptable; we therefore would hope to elicit from those who judge the present system to need improvement the nature of such improvements. Some will be technical, some will be institutional. One group of suggested changes is set forth in the paper, *Outline for an Acceptable Nuclear Energy System.*[2] The main points of this approach are familiar to most of you:

1. A recognition, first of all, that a commitment to immensely long times requires more thought than does a commitment that is clearly of shorter duration.
2. A belief that nuclear energy is "special"; if poorly handled, it can lead to serious consequences. Moreover, it requires continuity of a sort that we are not ordinarily called on to articulate explicitly.
3. That it is not idle to speculate on the elements of a long-range future. What we do today does constrain what we do tomorrow.

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[2]Published as **Outline for an Acceptable Nuclear Future** by Alvin M. Weinberg. (Oak Ridge: Oak Ridge Associated Universities) 1977, ORAU/IEA(O)77-17.

4. That two considerations ought to dominate our views of a long-range nuclear future:
   a. Confining high-level radioactive operations to as few sites as possible. This implies dedicating only so much land to nuclear energy.
   b. Creating a cadre capable of operating the nuclear energy system safely and responsibly far into the future. A possible analogy is the dike system in Holland. The system has grown up gradually over the past 1000 years. It has created its own tradition, its own expertise, its own cadre.
5. That the present patterns of generating and distributing nuclear energy ought to be reexamined. Are the institutional patterns, largely based on the preexisting structure of utilities, architect engineers, and equipment suppliers, appropriate for the long term?

We want to stress, however, that the purpose of this workshop is not to discuss these particular suggestions, although these can be points of departure. Other suggestions have been put forward in the letters we have received, and they must receive full consideration.

II. Near-Term Issues (Phase I)

These are covered in two sessions:

1. *Regulatory and institutional.* The purpose is to examine whether regulation of nuclear energy ought to be modified seriously in the short run and whether other short-term institutional changes seem to be needed.
2. *Short-term fixes.* The discussion here will focus largely on technical improvements that may be considered for Phase I. Although the issues are mainly technical, some institutional questions may be addressed—in particular, the transition from Phase I to Phase II.

III. Long-Term Issues (Phase II)

This is a general airing of what we can usefully say about the shape of Phase II and what this implies for our present course.

IV. General Discussion

This session will be devoted to a free exchange between the participants.

We would hope that this workshop achieves two purposes: (1) to decide whether or not the whole conception of trying to work out a long-range acceptable nuclear future is sensible, and (2) to help crystallize the many ideas that are beginning to appear in various places for such a future. If, as we hope, the workshop concludes that this inquiry has been useful, we should then agree on a mechanism for continuing this dialogue to further explore promising ideas.

Appendix B

Key Issues

1. The need for energy growth and, therefore, nuclear energy.

2. The difficulties of predicting much beyond 25 years into the future (i.e., arrangements that seem impossible now may be very easy under future conditions).

3. To date, there is no demonstrated basis that nuclear power and its related activities have been hazardous to the public or the employees of nuclear installations or that these activities have led to safeguard hazards. Therefore, we should proceed with business as usual. Is this approach satisfactory with increased deployment of nuclear power plants?

4. Siting of future light water reactors and breeders; advantages/disadvantages of nuclear energy centers, of physical isolation.

5. Siting/collocation of reprocessing/fuel fabrication/waste management facilities; advantages/disadvantages of such centers, security implications.

6. Collocation of nuclear power plants with reprocessing/fuel fabrication. What is gained? What flexibility is lost?

7. Advantages/disadvantages of government ownership of generation, of the back end of the fuel cycle?

8. How to increase the viability of Phase I in preparation for the transition to Phase II, recognizing that the break between the light water reactor and breeder phases is not sharp?

9. How strongly are weapons proliferation and nuclear power generation coupled? What safeguards need to be imposed on the back end of the fuel cycle?

10. Do we need to overhaul the licensing process? Should the role of the NRC be reevaluated and the whole licensing process restructured? Is there merit in continued retrofitting of the present light water reactor systems?

11. What are the advantages/disadvantages of social isolation/a nuclear energy corps? Will these necessarily enhance the operational and security aspects of nuclear power plants?

12. Overall system responsibility—why should this reside with anyone but the owner-operator? Is there any benefit to turnkey construction? How can plant reliability be improved to enhance capacity factors?

13. What are the implications of delaying reprocessing if the breeder is delayed until the mid-1990s anyway? Is plutonium recycle in light water reactors essential?

14. Is the presently proposed waste isolation method satisfactory? Are there any other realistic options besides burial in geological formations?

15. If the United States foregoes the nuclear option in the long term, does it not also forego its in-

fluence on the international nuclear market and, therefore, on controlling proliferation?

16. Are we irrevocably committed to the liquid metal fast breeder reactor? Do we have the time and resources to develop a different breeder system?

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