第11回 原産年次大会 英語論文

1978年 3月

社団
法人 日本原子力産業会議

第11回　原産年次大会プログラム

期　日　昭和53年3月14日（火）～16日（木）
場　所　イイノ・ホール〔内幸町・飯野ビル7階〕東京都千代田区内幸町2－1－1
基　調　「原子力開発利用の調和ある発展のために」

第1日　3月14日（火）

開会セッション（9：30～10：30）

議　長　圓城寺　次郎　氏（日本経済新聞社会長
日本原子力産業会議副会長）

9：30　大会準備委員長挨拶　稲葉　秀三　氏（産業研究所理事長　日本原子力産業会議常任理事）

9：40　原産会長所信表明　有澤　廣巳　氏（日本原子力産業会議会長）

10：10　原子力委員長所感　熊谷　太三郎　氏（国務大臣科学技術庁長官　原子力委員会委員長）

セッション1「原子力開発の国際的展望」（10：30～18：00）

（国際パネル討論）

〔前　半〕

（10：30～12：30）

議　長　一本松　珠璣　氏（日本原子力発電㈱取締役相談役　日本原子力産業会議副会長）

10：30　原子力発電の展望と国際情勢
①　S．エクルンド　氏（国際原子力機関事務総長）

11：10　フランスの原子力開発と国際協力
②　A．ジロー　氏（フランス原子力庁長官）

11：50　原子力発電と核不拡散
③　C．ウォルスキー氏（米国原子力産業会議理事長）

〔後　半〕

（13：30～18：00）

議　長　村田　浩　氏（原子力委員会委員　日本原子力研究所副理事長）

13：30　米国の核拡散防止政策――規制面からの見解
④　R．ケネディ　氏（米国原子力規制委員会委員）

14：10　オーストラリアのウラン政策

⑤　D．ジョージ 氏（オーストラリア原子力委員会委員長）

14：50　イランの原子力開発と国際協力の考え方

⑥　A．エテマド 氏（イラン原子力庁総裁）

15：30　日本の原子力開発と国際問題

新関欽哉 氏（原子力委員会委員）

＜休憩（10 分）＞

16：20　パネル討論

上記発表者のほかにM.ポップ氏（西独研究技術省エネルギー研究・技術開発部長）が参加。

レセプション　（18：30～20：00）

日本工業クラブ　＜3階　大食堂＞

第2日　3月15日（水）

セッション2「高速増殖炉開発ー実用化への展望」（9：00～12：00）

（国際パネル討論）

議長　伊藤俊夫 氏（関西電力㈱副社長）

9：05　フランスにおける高速増殖炉開発計画――実用化への見通し

⑦　M．ローゼノルク氏（フランス・ノバトム社社長）

9：35　ソ連における高速増殖炉開発の展望

8　N．クラスノヤロフ氏（ソ連原子力利用国家委員会 原子炉研究所副所長）

10：05　米国の増殖炉計画　過去，現在および将来

⑨　S．ブルーワー 氏（米国エネルギー省　原子力計画・分析部長）

＜休憩（10分間）＞

10：45　わが国の高速増殖炉開発計画

大山 彰 氏（動力炉・核燃料開発事業団理事 高速増殖炉開発本部本部長）

11：15　FBRエンジニアリング事務所について

高市利夫 氏（FBRエンジニアリング事務所所長）

11：25　パネル討論

午　餐　会（12：20～14：10）＜ホテル・オークラ別館地下２階　曙の間＞

通商産業大臣所感
代読
平井卓志通商産業政務次官

〔特別講演〕　歴史における科学と社会
木村　尚三郎　氏　（東京大学教養学部教授）

原子力関係映画上映（12：40～14：10）＜イイノホール＞

自　由　参　加

1. 「金属材料を追う　―原子炉の信頼性を求めて―　」（原研製作：日本語）
2. 「常陽臨界へ」（動燃製作：日本語）
3. 「キャスク輸送時の安全性実験」（米国サンディア研製作：英語）
4. 「フェニックス炉中間熱交換器の修理」（NOVATOME 製作：英語）

セッション３「軽水炉システムの現状と課題」（14：30～17：30）

（講　演）

〔前　半〕（14:30～15:55）

議　長　吉岡俊男　氏　（日本原子力発電㈱副社長）

14：30　議長イントロダクション

14：45　軽水炉の改良標準化

豊田正敏　氏　（東京電力㈱取締役 原子力開発本部副本部長）

15：15　軽水炉の稼働率向上への努力

(1)　加圧水型炉

藤原菊男　氏　（三菱重工業㈱ 原動機事業本部原子力技術部長）

(2)　沸騰水型炉

牧浦隆太郎　氏　（東京芝浦電気㈱取締役 原子力事業本部本部長）

＜休　憩　（10 分）＞

〔後　半〕（16:05～17:30）

議　長　大隅改介　氏　（住友原子力工業㈱社長）

16：05　日本における濃縮・再処理の技術開発の現況

天沼　倞　氏　（動力炉・核燃料開発事業団 核燃料開発本部副本部長）

16：45　西ドイツにおける放射性廃棄物管理

⑩　H. クラウゼ　氏　（西独カールスルーエ研究所 廃棄物研究開発部長）

⑪　M. ポップ　氏　（西独研究技術省 エネルギー研究技術開発部長）

第3日　3月16日（木）

セッション4「原子力開発のパブリック・アクセプタンスへの提言」

（9：30～12：30）

（国際パネル討論）

議　長　岸本　康　氏　（共同通信社論説副委員長）

9：40　西ドイツにおける原子力発電のパブリック・アクセプタンス

⑫　T. ローザー　氏　（西独原子力産業会議事務局長）

10：00　スウェーデンの原子力事情

⑬　S. サンドストレーム氏　（スウェーデン原子力産業会議事務局長）

10：20　米国における原子力発電――論争の範囲と傾向

⑭　L. オドンネル　氏　（ゼネラル・アトミック社社長補佐）

10：40　日本におけるパブリック・アクセプタンスの隘路

田原総一朗　氏　（評論家）

11：00　日本における原子力立地とパブリック・アクセプタンス

高橋　宏　氏　（通商産業省資源エネルギー庁原子力発電課長）

＜休　憩＞

11：30　パネル討論

セッション5「原子力論争ー原子炉の工学的安全性をめぐって」

（14：00～17：00）

（パネル討論）

議　長　柴田俊一　氏　（京都大学教授 京都大学原子炉実験所所長）

〔パネリスト〕

槌田　劭　氏　（京都大学工学部助教授）

都甲泰正　氏　（東京大学工学部教授）

能沢正雄　氏　（日本原子力研究所安全工学部長）

服部　学　氏　（立教大学助教授）

3/27
Final

発表は 3 月 14 日 午前 10時 [illegible]

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CHECK AGAINST DELIVERY

セッション1

ELEVENTH ANNUAL CONFERENCE OF JAPAN ATOMIC INDUSTRIAL FORUM

Tokyo, 14 - 16 March 1978

エクランド
final

THE OUTLOOK FOR NUCLEAR POWER AND ITS INTERNATIONAL ASPECTS

Address by Sigvard Eklund
Director General
International Atomic Energy Agency

14 March 1978

May I say how honoured I am to be a speaker in this debate on the future outlook of nuclear energy development in the world and on the role of international organizations.

It seems that there is hardly a country which would be more suitable to serve as a host for these discussions than Japan. Starting from a low level in 1945, she has now become the third greatest industrial power of the world. Yet this amazing achievement, due above all to the skill, abilities and discipline of her people, is also dependent on the availability of vast amounts of energy which, in this case, essentially means imported energy. As Table 1 eloquently shows, Japan is critically dependent on energy imports for almost 90% of her total energy needs and for more than 99% of her oil requirements.

It is not surprising, therefore, that the combination of a great reservoir of highly skilled human resources with a great scarcity of natural resources has led this country to launch a vast nuclear power programme. This programme is designed to achieve a major contribution of nuclear energy to meet the growing needs of a rapidly expanding economy and thus to alleviate the heavy burden of oil imports which the 1973-74 oil crisis has placed upon Japan and which, if I am not mistaken, amounted in 1977 to about 240 million tons of oil worth about 23 billion US$.

Yet the achievement of the objectives which were set immediately after the quadrupling of oil prices in 1973-74 seems to be now open to doubt and it is reported that the Japanese Government's Overall Energy Council finds itself compelled to consider the alternative target for 1985 of 26 000 MW(e) of nuclear capacity down from a higher figure originally planned.

That Japan is not an isolated case is evident from Table 2 which shows the downward revisions which have occurred in nuclear power plans throughout the world between 1973 and 1974. For all countries with market economies taken together, there have been reductions of the order of 40% for 1985 and of 38% to 45% for 1990 in the nuclear power estimates. Let me hasten to say that reductions have also taken place in the estimates of growth of total electric power demand, both as a result of the 1975 recession and the existing over-capacity in, for example, the US, and more significantly as a consequence of the lowering of expected future rates of energy demand expansion over the longer term. Nevertheless, the drop in total electric power demand forecasts is smaller than that of nuclear power projections. Both effects are illustrated in Table 3 which shows the evolution of orders for new power plants in the particularly striking case of the USA between 1970 and 1977. As will be seen, the years 1975, 1976 and 1977 are marked by a sharp decrease in both conventional and nuclear orders but the drop in nuclear is steeper and its share in the total of new orders sharply lower than the

50% to 70% which had prevailed over the preceding three years.

These developments, after a 300% to 400% rise in the price of oil, constitute a paradox which cannot be explained by either technical or economic reasons. As we shall see, nuclear power plants have had an excellent operating record and, while their costs have risen, they still retain in most countries a marked competitive advantage over fossil-fuelled-fired stations. The causes for the paradox of shrinking nuclear power plants in the face of sharply higher fossil fuel prices must, therefore, be sought beyond technical and economic considerations. They seem to lie in an accumulation of uncertainties which has given rise to doubts and to a variety of nuclear opposition movements. These uncertainties occur on both the national and international levels and consequently they can only be removed by national and international action in the formulation of which international organizations may have a major role to play.

Let me review briefly the four categories of topics I have just mentioned: the technical status of nuclear power, its economic competitiveness, the obstacles of its expansion encounters and the present and future role of international organizations in coping with these obstacles.

At the end of 1977 there were, throughout the world, 202 nuclear power plants in operation whose total capacity approached 100 000 MW(e) with 17 units with a capacity of 13 500 MW(e) coming on line during the year.

Up to that time, 1500 reactor years of civilian nuclear plant operating experience had been accumulated without a single radiationinduced fatality or any significant spread of radioactivity in the environment of a nuclear power plant for peaceful purposes.

With regard to availability, the overall performance of nuclear stations presented in Figure 1 shows an average load factor[1/] of all reporting nuclear plants remaining practically constant at about 62% over the last five years versus about 70% for base loaded conventional stations. It should be interpreted with some care. In particular, the fact that a majority of the stations considered had been operating for less than three years ought to be remembered. A look at Figures 2 & 3, which give the load factor as a function of age, confirms this impression. True, the number of large nuclear stations having more than five years of operation is small, and no reliable statistical inference can be drawn. But there is at least an indication that availability improves with age once the break in problems of the first few years has been overcome.

In this connection, the excellent record of operation of nuclear stations during the harsh winter of 1977 is particularly worth remembering. For the period of the first three months of that year, the load factor of seven nuclear plants in New England, USA, averaged 86%, that of the four Pickering Units in Canada more than 90%, and that of five nuclear power plants in Sweden more than 75%.

1/ The load factor is defined as the ratio between the energy that a power plant has produced during the period considered and the energy it could have produced if it had operated at maximum capacity during that period. The operating factor on the other hand is the ratio between the time the unit was on line and the duration of the period.

~~While it is obviously too early to speak of operational statistics for advanced nuclear systems, it is worth noting that the operation of the three fast reactors in the world, BN-360 in the USSR, Phenix in France, and PFR in the United Kingdom, have shown no insuperable technological or safety difficulties. In particular, the problems connected with the steam generators seem to be quite well understood. The firm belief in the future of these systems has been demonstrated not only by the three above-mentioned countries, where bigger commercial sized units are being built or designed, but also through the construction of other prototypes in the Federal Republic of Germany and the start of the construction of a prototype reactor in Japan.~~

Since the technical operational record can certainly not account for the reduction of future objectives and the dwindling of new orders for nuclear power plants, the next step is to look at the evolution of their costs and of their competitive position.

Table 4 presents a highly simplified, but generally valid, picture of the changes in unit investment costs which have taken place between 1967 and 1977 for nuclear, coal-fired and oil-fired electric power stations in the 1000 MW(e) range. There is hardly any need to stress the approximate character of such generalized estimates, which do not refer to any precise site with its specific local conditions. Subject to this reservation, the Table does, however, point to some interesting conclusions:

(1) The capital costs of nuclear power plants have roughly quintupled over the last ten years when expressed in current US dollars.

(2) They have been multiplied by a factor between 2 and 3 when expressed in dollars of constant purchasing power, a procedure which removes the effect of general inflation on the comparison and thus shows the differential increase of nuclear investment costs over and above the rise of the general price level.

(3) The unit capital costs of coal- and oil-fired stations have been multiplied by almost exactly the same factors over this period.

It would be outside the scope of this presentation to engage in an analysis of the causes of these increases in real power investment costs. There is no question that safety and environmental considerations leading to a multiplication of standards, large increases in manpower and materials, lengthened prelicensing and construction times have played a major role in this development but, regardless of the underlying reasons, the main conclusion seems to be that nuclear and conventional stations have been equally affected by these factors and that, as far as capital costs are concerned, the competitive position of nuclear power has hardly been altered by these dramatic changes.

Let us now look at the comparative changes of nuclear and conventional fuel costs summarized in Table 5. There, the position is more complex. First, the comparison had to be restricted to nuclear fuel and oil. The ranges of prices for coal are so wide and the transportation components so important that any generalized cost figures would be meaningless in its case. Secondly, the nuclear fuel costs had to be broken down in some of its major components, uranium enrichment and fabrication. Thirdly, the present economies of reprocessing are so uncertain that it was left out of the comparison. Nevertheless, some interesting conclusions emerge:

(1) The rise in the price of natural uranium, at least for spot deliveries, practically paralleled the rise of the price of oil, growing by a factor of 4 to 6 in current terms and 2 to 3 in real terms.

(2) The cost of enrichment rose much less, increasing by a factor of about 2.6 to 3 in current and 1.3 to 1.5 in real terms.

(3) Fabrication costs kept pace with inflation and consequently remained constant in real terms.

(4) As a result of these divergent trends, while nuclear fuel costs per Kwh increased from 1.5 - 1.8 mills in 1967 to 5 - 7 mills in 1977, the corresponding costs for the Kwh based on oil rose much more drastically from a range of 3.5 - 4.4 mills to 21 - 24 mills over the same period. Corrected for general inflation, the figures for nuclear fuel would become 2.5 - 3.5 mills and for oil 10.5 - 12 mills of 1967 purchasing power.

(5) As a result, the fuel cost advantage of nuclear over oil has considerably widened and reaches at present 16 - 17 current mills per kilowatthour produced.

The maintenance of a constant relation between the capital costs of nuclear and fossil stations and a widening favourable margin for nuclear fuel costs lead to the conclusion that whenever the choice of a large electric unit intended for base load duty is restricted to a nuclear and an oil-fired station, the former has an economic advantage which is substantially greater now than before the oil crisis. In the case of coal, the situation is more complex. ~~If coal were priced on the basis of therm parity with oil, the above conclusions would, of course, apply. If it is priced on the basis of production costs, there may be locations near particularly favourable deposits where strip mining is possible, which would give a competitive edge to coal-fired stations. Only detailed studies of specific cases can provide definite conclusions.~~

It may be argued that, while the present situation is perhaps favourable, little is known about the future. An analysis of possible changes in the main factors does not, however, affect in any way the case for nuclear power.

The present state of uranium resources with 2 million tons of reasonably assured and another 2 million tons of estimated additional reserves amply covers the needs of the maximum nuclear power programmes up to the year 2000. Of course, new discoveries are essential for maintaining forward reserves and meeting the lifetime requirements of the nuclear stations which will be operating beyond the turn of the century, but the present price levels have brought about a major prospecting effort whose first results are rather encouraging. The search for uranium, which had been limited to low-cost deposits in selected countries, has left wide areas of the world unaffected, for instance in Latin America and South East Asia. Hence, there is no reason to believe that uranium prices could rise faster than oil prices.

Regarding the other sector of the nuclear fuel cycle, neither the cost of enrichment, where several new processes will be competing with gas diffusion, nor that of fabrication are expected to rise faster than the general price level of industrial goods. ~~Finally, while it is difficult to pinpoint the net benefit or cost of reprocessing and recycling, its influence on total nuclear generating costs can hardly be expected to be significant.~~

Naturally, in the longer run, increasingly costly uranium ores would have to be mined if today's power plants, which use less than 0.5% of the potential energy obtainable from a unit mass of uranium, were to remain the main basis of expanding nuclear power programmes, but the efforts at present applied to the development of commercial breeder reactors in major industrial countries provide a solid foundation for a nuclear economy whose fuel resources would become practically unlimited, both as a result of a hundredfold increase in the energy which could be derived from known uranium resources, and the economic possibility of mining much poorer uranium ores.

Thus, we are brought back to our original question: considering the technical reliability and the present and future economic advantages of nuclear power, what are the reasons for its present difficulties?

The answer requires a brief analysis of a chain of events adding up to a genuine vicious circle. Certain aspects of nuclear power and of its fuel cycle have given rise to doubts and uncertainties, some of which are based on fact, and many on imagination. As a result, nuclear opposition movements have grown among private citizens in some countries and restrictive laws and regulations have been enacted by some governments in others. The campaign unleashed by these groups and the impacts of these regulations have brought about serious difficulties for the decision-makers in the electric power sector, thus reinforcing the initial uncertainties. As a result, delays, cancellations and cost overruns have occurred, which are then used in some quarters as arguments against the reliability of estimates of nuclear power performance and costs.

Let us briefly review the initial uncertainties on which these developments were based, trying to separate the real from the imaginary.

The main problems can be classified under two headings: ecology and non-proliferation.

With regard to the impact of nuclear power on the environment, it has, in many respects, become a victim of its own thoroughness. No other source of energy, indeed no industrial technology, has ever been the subject of such comprehensive and detailed analyses of its environmental effects. The results of these studies have led to two major conclusions:

(1) Under normal operating conditions, the release of radioactivity to the environment caused by operating reactors and their fuel cycle infrastructure within the scope of the largest programmes contemplated for the year 2000 would represent a very small fraction of the natural radiation burden.

(2) The mathematical expectation of human and property damages resulting from nuclear accidents within these programmes is a very small fraction of the overall risks involved in the life style of an industrial society.

However, these generally favourable conclusions do not in any way imply that no work remains to be done on the ecological effects of nuclear power.

Among the major areas which call for additional investigation and action are: further improvements of nuclear safety, decommissioning of nuclear installations and, above all, the closing of the nuclear fuel cycle, especially with regard to the storage and ultimate disposal of radioactive wastes. At the same time, more thorough analyses of comparative environmental impacts of different energy sources are essential to achieve a reasonable perspective on the consequences of alternative energy strategies.

The other category of problems stems from a very legitimate concern over the possible proliferation of nuclear weapons. However valid this preoccupation may be, it has sometimes been coupled with a not valid argument according to which the expansion of nuclear civilian power programmes is unavoidably linked with an increased probability of military applications.

Although the history of nuclear energy offers not a single example of such correlation, there still remain lingering doubts which only a comprehensive system of controls and safeguards, freely accepted by all parties, can finally dispel.

As was already mentioned, these primary uncertainties have given rise to a series of actions which have in turn brought about secondary uncertainties in such fields as, for instance, nuclear power plants licensing and construction times, assurances of nuclear fuel supply, ultimate fate of irradiated fuel, which sometimes outweigh the clear economic advantages. While the bulk of the efforts required for the solution of the problems I have just mentioned will have to be borne by national governments, many of them have international implications with which only an international approach can successfully cope.

The question thus arises: what can international organizations do to diminish these uncertainties or, as Under-Secretary Myers of DOE put it recently at the NEA 20th Anniversary in Paris, what contribution can we make to the "management of uncertainties"?

As we have seen, there are still uncertainties, at least in the public mind, on certain technical questions, particularly on certain aspects of nuclear safety and waste management. The IAEA and the Nuclear

Energy Agency in Paris have been toiling away for many years to establish internationally acceptable standards, guidelines and procedures that will not only help to ensure the safe design, construction, operation and siting of nuclear plants but will also give the necessary reassurance to the public. ~~The limited resources at our disposal mean that all major R and D on nuclear safety must be a national effort. Our own work must concentrate on harmonizing these efforts, on distilling a consensus and on giving this consensus a truly international authority which should at least carry more weight in the public mind than the efforts of national nuclear bodies.~~ For these reasons too, we have brought safety and environment oriented organizations, such as the World Health Organization, the United Nations Environmental Programme, the International Labour Organization and others, fully into our work.

As a result, it may be truly said that international nuclear safety standards today have the full endorsement of the world's health and safety authorities, as well as all its nuclear regulatory authorities. It must also be frankly said, however, that this has not made these standards by any means immune from attack and criticism.

In the Agency we shall continue to complete the comprehensive nuclear safety standards programme which, year by year, is extending its coverage to every aspect of the safety and the current generation of nuclear power reactors. ~~We shall, of course, also continue all other lines of our nuclear safety and waste management work and we shall continue to call upon the best available technical advice for this purpose.~~

While this work is very valuable, there is one major element which, in my view, is still missing. This is the fact that there has still not been any industrial-scale national or international demonstration of the viability of final geological disposal of high-level waste. This must become a top priority. The focus of environmental criticism has shifted with time from reactor operation and the risks of reactor accidents and now chiefly concentrates on what it considers to be the main chink in the armour of the nuclear industry, namely, final high-level waste disposal.

This is an important technological "uncertainty", not in the sense that it is insoluble - far from it - but in the sense that the solution has not yet been demonstrated for the world to see.

However, it must be repeated again that the major uncertainty which nuclear energy must overcome is not technological but political and lies in the changing policies of governments.

At the root of this uncertainty is concern about the further proliferation of nuclear weapons, a concern which made a quantum jump in 1974 and which deepened again last year with reports that nuclear weapons might be spreading to other areas of acute political concern.

We in the IAEA have been working with the problems of proliferation since the very start. In fact, this problem is perhaps the major raison d'être of the organization. I myself in the early 60's, in annual statements to the General Assembly of the United Nations, tried to draw attention, with scant success at the time, to the growing amounts of plutonium which were bound to be produced by the expansion of nuclear technology and I stressed the consequent need for truly effective and universal safeguards. It is not, therefore, for us to belittle in any way the risk of proliferation but we must try to see it in its true perspective.

The history of the last thirty years has demonstrated that even the most strenuous efforts at control will not prevent the slow but steady spread of the technology needed to produce highly enriched uranium or separate plutonium. I see little prospect that the next thirty years will show us the way of creating technological or legal barriers against dissemination of industrial technologies - and I don't think this is what we truly want. I repeat what I have said before: I don't believe that a policy of denial could be either realistic or effective. What is, however, necessary now is to strengthen the existing international framework aiming at the non-proliferation of nuclear weapons. I am sure that in this context the IAEA can make a major contribution to diminishing the political uncertainty by applying safeguards, what is called full-scope safeguards, effectively and universally in the non-nuclear-weapon States, or to be instrumental in other non-proliferation measures complementary to safeguards. Whether this universality of safeguards can be achieved, or other measures agreed upon, is up to the statesmen of the world. It is not a matter within our power in Vienna.

Since 1974, there has been a growing apprehension that even effective safeguards may not be adequate to prevent proliferation if a country already has within its reach the means of producing nuclear explosive material. Debate has focused on the question of detection times or the "timely warning" needed to give diplomacy enough time to act upon the would-be diverter after he has begun the process of diversion but before the explosion takes place.

Until now it has been the IAEA's view that the chief political value of safeguards was to give other countries the continuing assurance that the safeguarded country was not diverting - to remove this particular uncertainty - rather than to give time for international diplomatic action after a decision to divert has already been made. It still seems to us in Vienna that the continuous assurance of non-diversion rather than the last-minute prevention of an intended diversion must remain the main objective of safeguards.

Nevertheless, we would all agree that the world would be a better place if the production of enriched uranium and plutonium were concentrated in as few localities as possible and were preferably undertaken in large, truly commercial plants operated under international or regional auspices. It is also in all our interests that the political uncertainties that have beset the supply of nuclear fuel and particularly enriched fuel in recent years could be diminished.

These are some of the questions with which INFCE is now engaging itself and in which Japan is taking an active part. ~~As you know, INFCE has eight working groups. No.1 deals with fuel and heavy water availability; No.2 with enrichment availability; No.3 with assurances of long-term supply; No.4, of which Japan is a co-chairman, with reprocessing and plutonium; No.5 with fast breeders; No.6 with spent fuel management; No.7 with waste management and disposal, and No.8 with advanced fuel cycle and reactor concepts.~~

While the main focus of this work is in Vienna and the IAEA is providing meeting services and in some cases a technical secretariat for the working groups, INFCE is an autonomous undertaking and does not form part of the IAEA's programme and is not in any way under our direction.

INFCE is expected to complete its work by the end of next year. It is reasonable to assume that INFCE will develop useful information and new concepts and insights on the problems that face us. To take one of the many aspects, it is quite clear that the problems of management of growing quantities of both spent fuel and of separated plutonium during the next few decades, will call for an increasingly close international co-operation.

Another international aspect of particular interest is the assurance of fuel and other technological supplies. Proliferation fears and particularly the misgivings about the spread of plutonium have led in the last two years to major changes in international fuel supply. The first group of changes which Japan, as well as sixteen other countries, has now made a matter of national policy, is enshrined in the so-called "London Guidelines". I must express my regret that these guidelines do not yet include the requirement for full scope safeguards.

The second and more far-reaching group of changes directed particularly as restraining the reprocessing of spent fuel is contained in the new United States legislation. This legislation is also reflected in an amendment now before the Agency's Board of Governors to the Co-operation Agreement between the IAEA and the US. This agreement has been the main source, in fact practically the only source, of fuel for the IAEA's supplies to the nuclear programme of its Member States. The United States is negotiating similar amendments to its bilateral agreements with other countries as well as in its agreement with EURATOM.

It may be worth while to summarize some of the main conditions upon which the US will generally insist in future export arrangements. I use the phrase "generally insist", since I understand that the legislation would permit the President in very special circumstances to make exceptions. The legislation is very complex, and I shall summarize some of the main points as reflected in the suggested amended US/IAEA Agreement.

Firstly, no nuclear material, equipment or facilities may be supplied through the Agency unless, at the date of transfer, there are one or more agreements in force with the importing country which apply safeguards to all nuclear activities in that country or under its control or jurisdiction. In other words, no supply may be made unless, at the time of supply, the importing country is a party to NPT or has concluded agreements which add up to full-scope safeguards. How far this affects exports to nuclear-weapon States is not clear to us at this time.

Secondly, supply agreements will permit the United States to obtain information about all nuclear material under safeguards in the importing State irrespective of whether the material was of US origin or not. However, in the case of NPT countries, the US need only be informed about inventories of nuclear material coming under the supply agreement - essentially, nuclear material of US origin.

Thirdly, the prior consent of the United States will be required for any arrangements for storing separated Pu, U^{233} or uranium enriched about twenty per cent.

Fourthly, prior US consent will be required for any reprocessing of material originating in the supply agreement or for any alteration of the form or content of certain sensitive materials (Pu, U^{233}, 20%-enriched U^{235} or other irradiated material).

Fifthly, there shall be no enrichment up to twenty percent of U^{235} unless the United States agrees in advance, and no enrichment to twenty per cent or more unless this is foreseen in the supply agreement.

Sixthly, specified standards of physical protection must be applied to all material, equipment or facilities supplied by the United States or originating in such supplies. At a minimum, the levels of protection must be those recommended by the Agency.

Seventhly, no sensitive nuclear technology may be transferred unless the agreement specifically provides for such transfer. Sensitive technologies include enrichment, reprocessing, heavy water production and Pu fuel fabrication as well as other information designated in advance by the United States.

Eighthly, there may be no retransfer of supplied items or produced nuclear material without prior agreement by the United States.

The new legislation also foresees that if the IAEA is not able to apply its safeguards for any reason, the United States' safeguards will be applied in the importing country.

The legislation also contains a number of sanctions to be applied if, for instance, the importing country carries out an unsafeguarded activity, does not permit the Agency to apply safeguards, detonates a nuclear explosive device or otherwise fails to comply with an Agency safeguards agreement.

I have consistently urged that supplies should only take place to NPT countries or to countries which at least have accepted full-scope safeguards. This aspect of the new legislation is, therefore, in my view, a positive development. Whether the successive imposition of increasingly strict bilateral controls in other matters, including restraints on the freedom of action of the importing country to carry out normal nuclear industrial activities even under safeguards - whether such additional restraints will achieve their non-proliferation objects in the long run, or will encourage tendencies to national and regional nuclear self-sufficiency, remains to be seen. It seems to me to be difficult to reconcile such actions with Article IV of the NPT.

During the past couple of years, we have in effect seen a return to the policies of the late 1940s and early 1950s when the major suppliers sought to prevent proliferation by rigid and extensive controls. This has now inevitably led to confrontations in the international field, parallelling the confrontations in the national field between the nuclear industry and the violent opposition to it.

I cannot believe that such confrontations will provide the answers that we are seeking. I hope, therefore, that we may soon turn another page and begin the search for international and multinational solutions to our problems, gradually replacing the barriers of restraint and denial by co-operative undertakings to deal with our fuel cycle problems.

Japan, which is more aware than most countries of the extent to which the supply of energy resources depends upon uninterrupted international co-operation, can play an extremely important part in the promotion of such co-operation. I have already referred to Japan's co-chairmanship of the INFCE Working Group on Reprocessing and Plutonium, but the Japanese initiatives for regional co-operation in the Pacific and South-East Asia could be most helpful. I look forward, for instance, to full Japanese participation in the already-existing regional co-operation agreement (RCA) which is helping to bring the benefits of nuclear science and technology to the countries of the reigon and, particularly, to the solution of their food and agricultural problems.

~~Japan already plays a very important part in the IAEA. One of the five Deputy Directors General is a distinguished Japanese scientist - Professor Kakihana - and two of the divisional directors are also distinguished Japanese experts - Professor Saiki and Dr. Haginoya. I hope that this professional contribution to our work can also be matched by even more generous voluntary contributions, for instance, to our technical assistance activities to which, it is true, Japan pays its assessed share, but which it is economically and scientifically in a position to go beyond.~~

It may seem idealistic to propose that the international community should seek new and far-reaching forms of multi-national co-operation in, for instance, the management of spent fuel and of separated Pu, the creation of regional fuel cycle centres, the codification of peaceful nuclear relations and the assured supply of enriched fuel. It must be remembered, however, that the development of peaceful nuclear technology has already led to important innovations in international and regional political structures and concepts. The Agency's safeguards system, the nuclear non-proliferation treaty, the multi-national reprocessing and enrichment arrangements already set up, represent advances in international thinking and action that would have been inconceivable a generation ago. It is for this reason that I consider it most important that new initiatives for international co-operation should prevail as soon as possible over the present tendencies towards restraint and denial.

Table 1

Energy Consumption per capita
and
Energy Self-Sufficiency of some Major Industrial Countries

	Energy Consumption per capita (Tons of oil equivalent)	Self-Sufficiency (%)	
		Total Energy	Oil
US....................	8	80	55
Federal Republic of Germany...........	4	50	4
France................	3.2	25	1
Japan.................	3.2	11	0.2

Table 2

Evolution of Estimates for the World[*] Nuclear Capacity from 1973 to 1977[**]

(1000 MW(e))

For:	1973 Estimate	1977 Estimate
1980......................	185-215	146-150
1985......................	475-600	280-370
1990......................	800-1280	500-700

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[*] Not including the countries with planned economies.

[**] Based on information submitted by member states to NEA-OECD.

Table 3

Evolution of Orders for Nuclear and Conventional Plants in the U.S.A.

(1000 MWe)

	Conventional	Nuclear	Total
1970............	30	15	45
1971............	16	20	36
1972............	16	36	52
1973............	26	40	66
1974............	34	35	69
1975............	11	5	16
1976............	5	3.9	8.9
1977............	8	5	13

Table 4

Estimated Unit Capital Costs of Nuclear Power Plants in the 1,000 MW(e) range* - 1967-1977

(US$/Kwe)

	1967	1977 (in 1977$)	1977 (in 1967$)
Nuclear	100-120	500-700	225-350
Coal	80-100	400-550	200-275
Oil	70-80	330-400	165-200

- Variable sites in industrialized countries with different environmental and seismic protection criteria.
- Single nuclear unit in the 1000-1300 MW(e) electric versus two fossil fueled units on the same site.
- Calcium based desulfurization for coal.
- Mechanical draft cooling towers, in all cases.
- Interest during construction and escalation not included.

TABLE 5

Estimated Costs of Nuclear Fuel and Oil

1967 - 1977

	1967	1977	
		In 1977$	In 1967$
Price of Uranium ($/16/$U_3$08) lb	6–8	25–42	12.50–21
Separative Work ($/KgSW)	25–30	66–100	33–50
Fabrication ($/Kg of U)	50–60	100–120	50–60
Nuclear Fuel Cost in LWR (Mills/Kwh)	1.5–1.8	5–7	2.5–3.5
Price of Oil ($/barrel)	2–2.50	12–14	6–7
Fuel Costs of Oil Fired Station (Mills/Kwh)	3.5–4.4	21–24	10.5–12

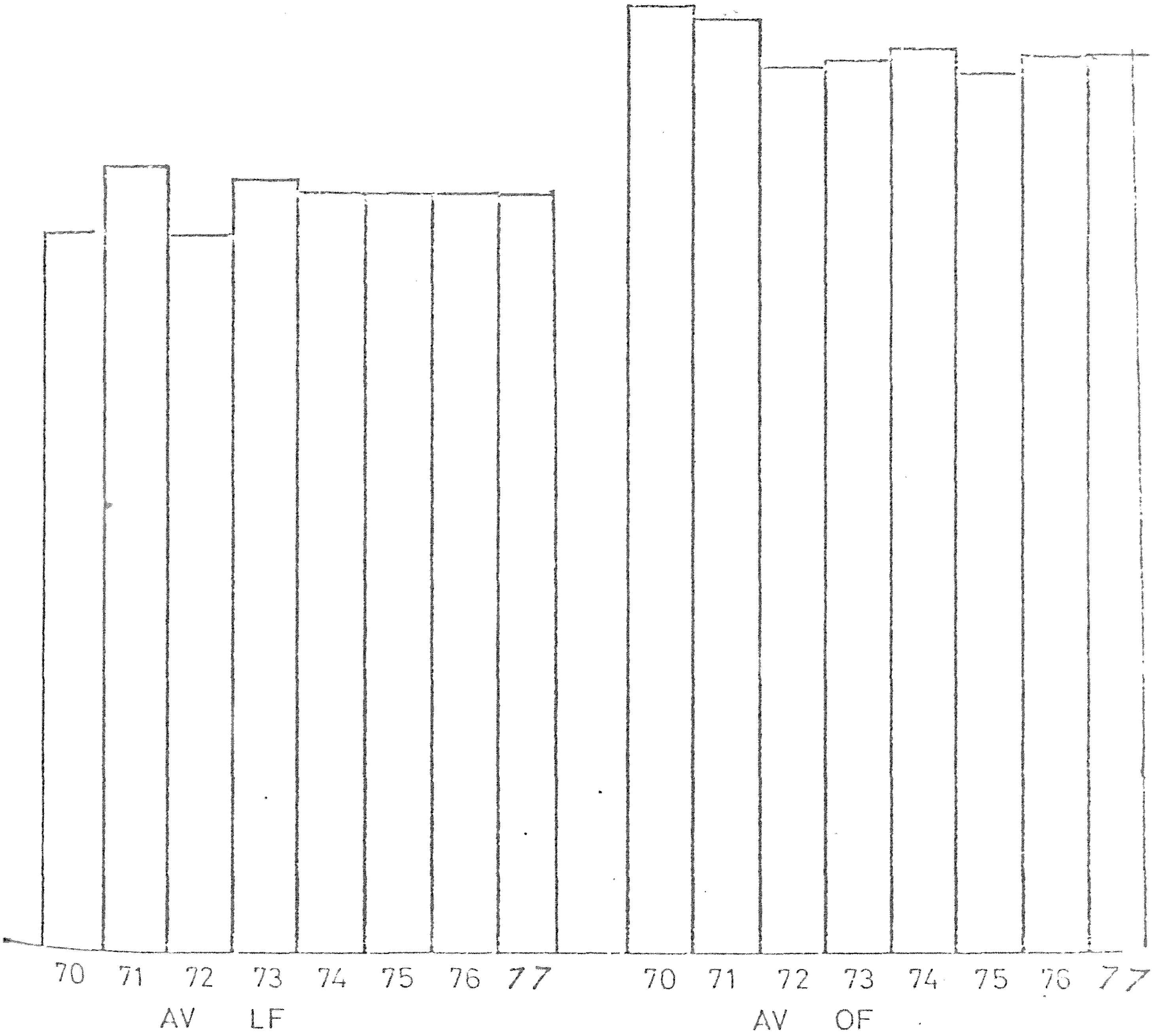

FIGURE 1
PERFORMANCE FACTORS
(ALL REACTORS REPORTED)

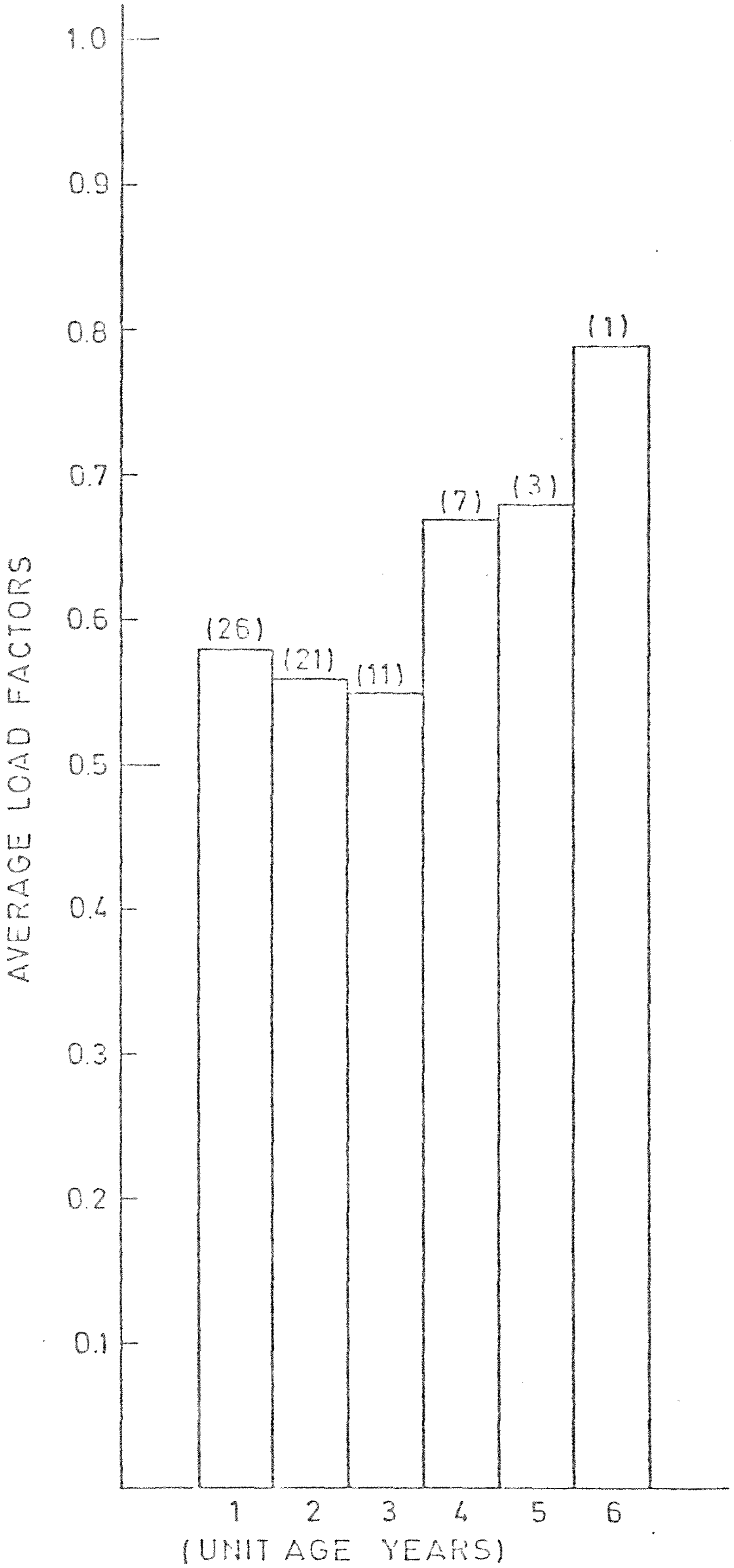

FIGURE 2

AVERAGE LOAD FACTORS OF PWRs OF >600 MW(e) AS A FUNCTION OF AGE
FIGURES IN PARENTESES INDICATE THE NUMBER OF UNITS

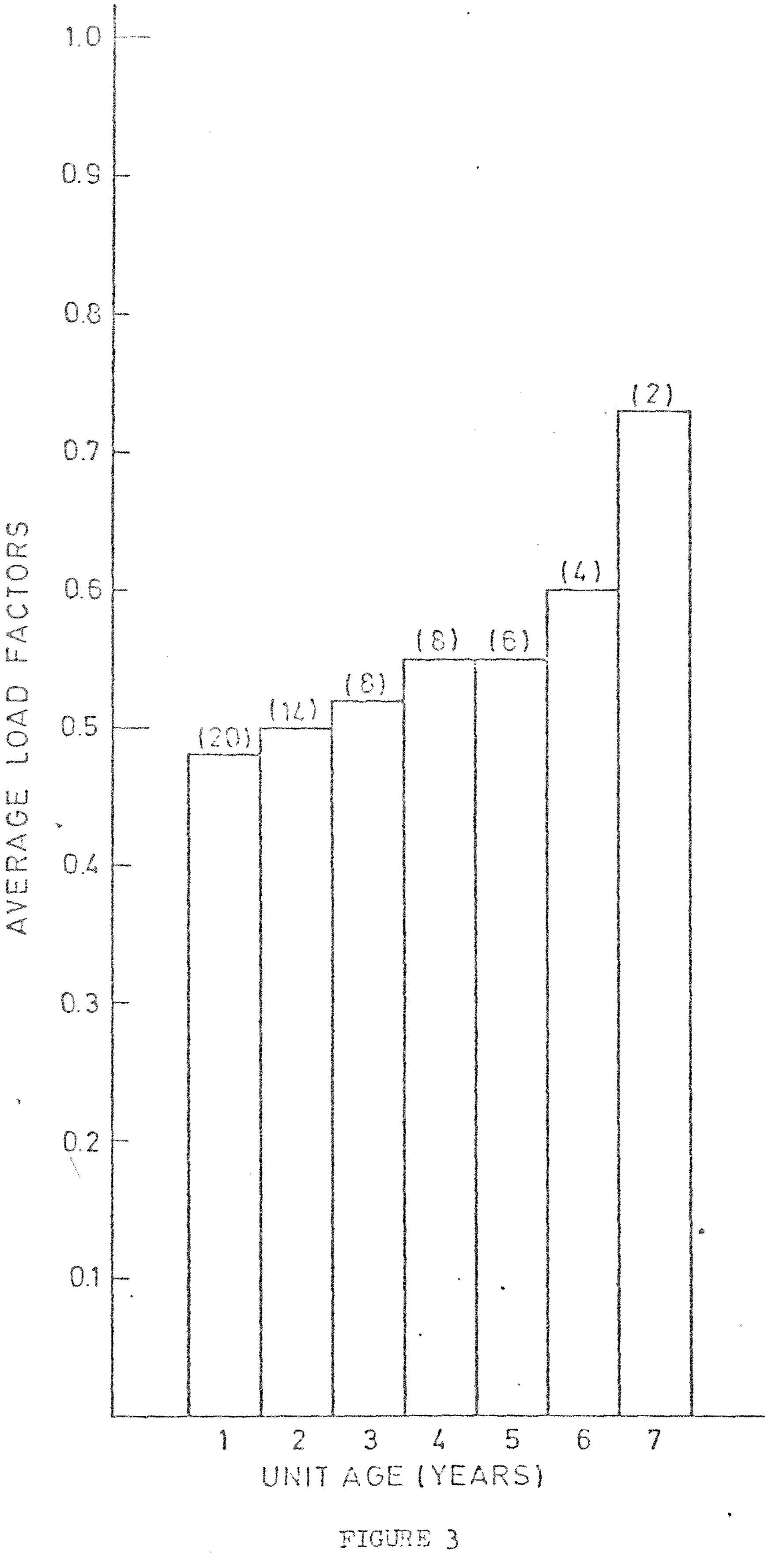

FIGURE 3

ERAGE LOAD FACTORS OF BWRs OF ≥600 MW(e) AS A FUNCTION OF AGE
FIGURES IN PARENTESES INDICATE THE NUMBER OF UNITS

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発表は 3 月 14 日 午前 11 時 10分 ~~午後 時~~
以降に願います。

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THE FRENCH NUCLEAR PROGRAM
AND INTERNATIONAL COOPERATION

by
André Y. Giraud, Chairman
French Atomic Energy Commission

1 NUCLEAR ENERGY : A PLANETARY NEED

Many studies of the world's energy future have been published during the past year. While differences can be seen in the figures given by the various authors, the trend is undoubtedly the same: consumption will at least double between 1975 and 2000 and reach 9 500 MTOE, approximately equally divided between the U.S.A., the industrialized countries and the Third World. (figure 1). Two reasons, at least, make us feel that those figures are minimum.

First, the assumption is made that the historical trend of the energy growth rate, marked by an average value of 5,2% during the 1955 - 1973 period, will be curbed down to the level of 3,3% during the next twenty five years. This will be achieved only through a considerable conservation effort concentrated within the highly industrialized countries, and meaning that in the year 2000 the energy consumption of the non-communist world will be two-thirds of what it would have been only following the past historical trend. Nothing warrants this result.

As for the Third World, different approaches have been used by different authors. They lead to consumption figures in the year 2000 ranging from

2000 Mtoe to 3000 Mtoe, far below the 5000 MTOE postulated by Leontieff as necessary to narrow the average inequality between developed countries and the Third World from 1/12 to 1/7. We feel that 2500 Mtoe is a minimum to guarantee survival and maintain hope in the Third World, while not yet solving the underdevelopment problem.

According to the same forecasts, the demand would be pursued in the following way : oil would decline from 55% to 45%. Hydroelectricity would remain at a modest figure (6% to 7%) and new energies would barely emerge (3% to 5%). The other 45% would be more or less divided between coal, gas and nuclear power. These figures represent a doubling in absolute value of the production from the traditional sources. Are they realistic ?

Known recoverable coal reserves can certainly provide us with 2200 million tons annually instead of the prevailing rate of 1200 million, but this implies a comprehensive development strategy which is neither impossible nor easy.

The case of oil is more embarrassing. Although reserves are smaller, it represents the bulk of our supply, and was the wellspring of the prodigious economic growth of the world between 1960 and 1973.

Figure 2 summarizes the different oil consumption forecasts from today to the year 2000. The large degree of uncertainty is reflected by the width of the cross-hatched area. Two curves reprinted from a Shell study indicate the production possibilities : curve P_1 represents the maximum feasibility capacity; curve P_2 represents a less optimistic but probably more realistic assumption, based on the completion and productivity of new wells. Whatever the assumptions, there is a clear risk of an oil shortage between 1985 and 2000. A more detailed analysis of production prospects, country by country, confirms the possibility of an oil crisis around 1985, the consequences of which would be tremendous.

One can imagine the political consequences of a competition between the U.S.A. which, en 1985, will account for about 40% of the consumption, and the other countries of the world, the industrialized and the poor. One can also measure the social and economic consequences of a shortage of oil, either in the industrialized countries where oil is absolutely necessary for specific uses or in developing countries where it is most often an essential development factor.

Thus, even if the worse does not always happen, the development of other sources of energy is a must, and the 1500 Mtoe predicted by MIT as a low assumption for nuclear power production in the year 2000 thus represents an irreplaceable contribution, which the world will certainly have to increase (we lean toward a level between 2000 and 2500 Mtoe).

It is not surprising that this situation is felt more deeply by those industrialized countries that are the most dependent upon oil imports, among them, Japan and France.

2 FRANCE ENERGY POLICY

In 1976 France consumed 175 Mtoe, while domestic production amounted to only 40 Mtoe (coal 18, oil 1.5, gas 6.5, hydro-electricity 11, nuclear 3). Hence France has a 77 % dependence on imports. This disequilibrium is the result of our lack of energy reserves, which is clearly shown by the following table.

Mtoe	(a) proved reserves	(b) 1976 consumption	years (a/b)
Coal	300	32	9
Gas	132	19	7
Oil	9	109	0
Total fossil fuel	541	160	3.4

Note that the possibilities of increasing hydro-electric power production are limited to no more than 5 additional Mtoe/year.

For us, energy supplies are therefore a major problem. The situation in Japan is similar, as the following table clearly reveals.

Mtoe	(a) reserves	(b) 1975 consumption	years (a/b)
Coal	1020	54	19
Gas	10	8	1
Oil	3	196	0
Total fossil fuel	1033	258	4

In the period from 1955 to 1976, France's energy dependence rose from 36 % to 77 %. We have thus reached a point of tremendous vulnerability and alarming disequilibrium in the balance of payments (the oil bill now represents more than 3% of the gross domestic product). The most abundant domestic fossil resource is coal, but a boost in output would raise infrastructure and social problems. It would lead to expensive energy, and it would solve nothing. Reserves would merely be exhausted sooner.

But France owns estimated uranium national reserves of 100,000 tons. While these reserves are not large, consumed in light water reactors, they nonetheless represent 800 Mtoe, or one-third of North Sea oil reserves. Through the use of breeder reactors, this uranium can produce 50,000 Mtoe, the equivalent of all Middle East oil reserves.

In a world which, as we have seen, has an absolute need for nuclear energy, France's choice for its energy policy, was obvious. The country had been actively involved in atomic energy research since 1938. In the wake of the 1973 oil crisis, the Government therefore decided to speed up the nuclear program, (figure 3) and called for the annual construction of 5000 MWe nuclear power capacity, or a minimum of five reactors, during the following decade. In order to avoid running into a shortage of uranium, it was necessary to combine this decision with a long-term strategy; a decision to use fast breeder reactors as soon as permitted by the development program which had been under way for over fifteen years. Phênix had just started operation to our entire satisfaction. Ground was broken in 1977 on the site of Super-Phênix, a 1200 MWe prototype, while commercial breeders start being designed to be put into operation before 1990 (Fig. 4 & 5) (photo : Le Bugey).

3 AN INDUSTRIAL POLICY TO MATCH OBJECTIVES

To match these objectives, our nuclear construction industry had to be organised. For the first generation of thermal reactors, we decided to select the light water system and after a period of reflection, to concentrate on a single system, the PWR.

Since 1958, Framatome, a subsidiary of one of the major mechanical industry groups, held the licence for the Westinghouse system. Since the decision to intensify nuclear development, Creusot Loire earmarked a financial effort to equip its subsidiary with a large, modern production capability. This led to the construction of the Chalon sur Saône workshops, which can produce 24 steam generators and 8 reactor vessels annualy (see photo), while Alsthom-Atlantique is equipped to deliver the turbosets. This means that eight 900 MW or six 1300 MW reactors can be manufactured annually. The installations were provided with slight excess capacity deliberately. Framatome can thus supply two units per year for export.

But the material investment would have been inadequate without a concomitant human investment: the creation of competent teams, capable of carrying through the construction of nuclear power plants on schedule, and the setting up of an effective quality control system were no trivial matter.

As we can foresee today, despite changes in facility design and in safety criteria, this ambitious program will be less than six months late (apart from the very first units which always raise problems owing to their originality), which can be considered as a satisfactory result.

Equally important is to give to the construction teams the backing of research and development. First to add the know-why to the know-how, and secondly to bring technical improvements to the product. Today's NSS systems do not represent the final perfect culmination of technology. A close cooperation between the supplier (Framatome) the utility (EDF) and the research and development organisation (CEA) looked desirable. Hence the Government decided that the CEA would acquire a share in the equity of Framatome, so as to narrow the link between research and construction teams and various agreements have been concluded between the partners to perform joint research and development (Fig. 6).

More recently another company called Novatome, which associates the CEA and industry, has been set up for the building and marketing of fast breeder reactors and other advanced systems. It is in charge of the Super-Phénix contract. But our venture in fast breeders has become international: France, Germany, Italy, Belgium and Netherlands have agreed to pool their development programs.

If we really wish to avoid impending energy shortages, we must broaden the outlet of nuclear energy. This is why the CEA through its subsidiary Technicatome, has undertaken work to exploit the know-how gained in the development of submarine reactors to design low-capacity reactors (100 to 150 MWe), intended to make the benefits of nuclear energy available to countries with small electric power grids and to supply isolated installations. These reactors are also suitable for surface propulsion and have been covered by a licensing agreement with the Japanese company IHI in this area. The CEA is the licensor and partner of another leading industrial group, Alsthom Atlantique. The heat market itself is another possible extension and has spurred considerable design work, involving the use of the foregoing reactors, or the creation of a system specifically designed for district heating.

4 AN ESSENTIAL FEATURE: THE FUEL CYCLE

When an NSS system enters service, it is important to ensure that it will be supplied with nuclear fuel during its 20 to 25 years of operation.

4.1. Uranium mines

From the very beginnings of nuclear energy, France gave serious thought to ensuring its uranium supplies. The national territory has been extensively prospected for uranium. The La Crouzille deposits were discovered in 1948, followed closely by the Forez deposits in 1950. Although substantial reserves have been discovered, it was considered desirable in view of future needs, to establish a French uranium industry operating both in France and abroad, not only for French clients but also for foreign utilities. Presently it handles roughly 5000 tons a year.

4.2 Isotopic separation

Following the 1969 decision to base nuclear generated electricity production on slightly enriched uranium reactors, it became all the more attractive to exploit our know-how, that this type of reactor would very likely gain preponderance over all others: a brilliant future could be anticipated for enriched uranium. France had conducted for several years, research on isotopic separation both for scientific and military reasons; an excellent scientific and technical capability had been acquired. Our country was thus in a good position to promote a project in cooperation with other countries which had the will to guarantee their supply of enrichment capacity. This resulted in the Eurodif project associating France, Italy, Spain, Belgium and Iran. The decision was accelerated by the Yom Kippur war which soon followed. The plant which remains within schedule and budget is due to start production in 1978 to reach its 10,8 MSWUS capacity in 1981.

4.3 Reprocessing

The idea of storing irradiated fuel for ever was discarded very early. Fuel elements are designed to withstand limited residence in a reactor core. The severe conditions to which they are subject lower their strength. Once they are unloaded, their integrity cannot be guaranteed over a long period. Metallic fuels are particularly brittle and disintegrate very rapidly in case of pool storage. Oxide fuels are more rugged, but their strength cannot be guaranteed and, moreover, they are far more bulky. Assemblies over five meters long, which would have to be placed in containers, could hardly be stored indefinitely in geological strata. Such an irradiated PWR fuel element contains 14 kg of fission products (about 2 million curies) and more than 4 kg of plutonium.

Ecological considerations alone would make reprocessing necessary. We shall see that it also allows a better management of the planet's resources.

From the start of our program, we took an active interest in plutonium separation. Once the process was developed, the reprocessing of the low burn-up Magnox fuel proved a relatively easy task.

Progressively, higher burn-ups spurred technological advances. This experience proved invaluable when we had to deal with the more complicated matter of reprocessing highly irradiated LWR oxide fuels. It is revealing to observe that the only two countries which offer reprocessing services are those which launched their nuclear industry with natural uranium/graphite/gas reactors. (Fig. 7) (photo : La Hague) (photo : Eurodif)

5 THE WORLD DIMENSION

No nuclear policy, in no nuclear country, can be established without reference to international cooperation. The world is threatened, as shown before, by a tremendous energy crisis of which we have experienced up to now only the first signs. Oil supply, coal supply are determined by an international market. Nobody can hope to solve its energy problem on a domestic basis. Nuclear supplies will have to be international as well, if the world wishes to avoid an energy shortage that would entail an unsolvable political problem and lead most likely to a war.

However, the transfer from one country to the other of nuclear materials, equipments or even knowledge, which was considered recommendable since Eisenhower's Atoms for Peace program, has recently become a main diplomatic issue. Some restrictions have been decided. Others are advocated, here and there. Most attention is given to preventing the proliferation of nuclear weapons.

Briefly, peaceful nuclear energy is indispensable and should be expanded through international cooperation and commerce, proliferation is a catastrophe which must be thwarted through restrictions on international cooperation and commerce. Can we escape the contradiction ?

The issue is a difficult one, which faces every government and deserves careful analysis to determine a set of measures and rules that will favour the expansion of peaceful nuclear energy while preventing the proliferation of nuclear weapons.

The materials that can be used for manufacturing nuclear weapons, highly enriched uranium and highly concentrated plutonium, fortunately enough, are not involved as such in the production of peaceful nuclear energy. Consequently, it must be possible to separate the two activities by a combination of technical solutions, a proper international organisation and political provisions.

1. Technical solutions

Obviously, it would not be of any use to impose restrictions on the operations involved in the production of peaceful nuclear energy if these operations were unable, by nature, to be diverted to military uses. And the availibility for a certain step of a technique having such a property if it is economical, makes ..unnecessary the international transfer for such a step of the techniques which are not proliferation resistant.

For uranium enrichment, we have announced a chemical process which makes it possible to build relatively modest capacity plants (1 to 3 MSWU) which are still economically profitable, but which cannot yield highly enriched uranium. We shall now, preferably in cooperation with other countries, move on to the demonstration stage (50.000 SWU).

For reprocessing, it is not necessary to use the conventional Purex method which has been developed in nuclear countries where, obviously, the production of plutonium, at a certain step of the process, does not increase proliferation. There are ways of avoiding the appearance of plutonium. There are even ways of spiking the plutonium while extracting it or after it has been turned into oxide fuel and before it leaves the reprocessing plant. The Civex process, recently suggested by american and english experts is also one of the variants of such proliferation proof techniques. We can consider very likely that the INFCE group working on this problem will come out with acceptable proliferation proof techniques.

The technical choice between the different types of reactors is also worth thinking. Of all nuclear reactors, the PWR LWR is the least susceptible to diversion of fissile material. In order to introduce or withdraw anything from the reactor, the cover must be removed. This is no easy matter and requires a long shutdown. Thus the LWR lends itself ideally to safeguards whereas the Candu or Magnox reactors allow the manufacture of military grade plutonium ~~through~~ and continuous fuel unloading.

The breeder has the same characteristics as LWR's : discontinuous unloading after complete shutdown. The proliferation problem with the breeder lies essentially upon the safeguarding of the fuel and blanket elements, new or spent. Moreover, the possession of plutonium is a prerequisite to its installation, implying the possession of first generation reactors in operation. This makes it a technique which will be reserved for some time to large industrial countries.

2. International organisation

In addition to selecting as much as possible proliferation-proof techniques, the international community might try to organise itself in such a way that the temptation of disseminating the sensitive technologies would be reduced. Let us take an example. It was unanimously agreed, up to 1976, when the american official opinion changed, and it is still largely considered by most of the experts, that reprocessing is a necessity: it remains the best if not the only proven method of conditioning the fission products and of destroying the plutonium by recycling it into thermal or fast neutron reactors. In addition it gives a way of conserving the precious energy content of fossil uranium ores. What will happen if there is no possibility for a country to have its fuel reprocessed elsewhere ? It will try to build its own reprocessing plant. And what will happen if the reprocessing know-how is not available from other countries ? It will try to develop it's own reprocessing technique, even if it is forced for a while, to defer reprocessing. The net result of the ban on reprocessing will be the dissemination of reprocessing.

This example shows that, contrary to what some people think, there are parts of the nuclear industry for which the development of international cooperation is of paramount importance. For many countries, nuclear energy is vital, and even without any military idea in the back of their minds, most of them will search for security of supply. At the same time, they will avoid uneconomical solutions - that is, very often, national solutions - provided that they feel they can rely on international supplies.

Thus, one way of decreasing the risks of proliferation is to promote such reliable international supplies. And "reliable" means several things. It means that enough capacities will be built in due time and that the customer believes that this is the case. It means that no sovereignity decision will change the conditions of supply, even disguised with the word "renegotiation". "Reliable" means also that through various ways (competition, audit of accounts, shares in equity etc.), the clients get the impression that the prices they pay is fair.

The above considerations plead in favour of developing natural uranium production and its commerce without undue constraints, toll enrichment and toll reprocessing in large plants, suitably located, using the proper techniques, and properly safeguarded. A very small number of such plants would be enough.

3. Political provisions

To complete, to back or to implement the above suggestions, international agreements or treaties have been or will be necessary.

International safeguarding is the best known example. It can become more refined, while at the same time, attention should be brought to give to the inspectors access to the know-how.

The London guide lines have been inspired by the idea that the exporting countries should keep the technology transfer outside their commercial competition. As I said before, transfer restrictions must in some cases be compensated by opening some other international cooperation.

The storage of surplus plutonium - until it is destroyed in reactors - seems to be fit to international management and its transportation - as well as the highly enriched uranium transportation - should be submitted to international rules. For instance, apart from exceptions, international transportation between reprocessing plants, storages and reactors should handle only mixed oxides suitable for manufacturing the fuel, and in some cases, the fuel itself, after a preliminary irradition.

We must always keep in mind that nuclear energy is necessary to the peace of the world, that every nation has the right to maintain its dignity and to define its energy policy and that if restrictions can be decided on, the transfer of fissile materials, components and know-how, science and knowledge cannot be reserved for a happy few. Any non proliferation policy that would not take those principles into account would prove sooner or later, a failure. On the contrary, taking advantage of the broad acceptance of the non proliferation idea, it is through a clever international cooperation combining technical advances, a proper industrial and commercial organisation of the supplies and well accepted rules that it will be possible to expand nuclear energy while decreasing the risk of weapon proliferation.

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CIVIL NUCLEAR POWER WITHOUT WEAPONS PROLIFERATION

Carl Walske
President
Atomic Industrial Forum, Inc.

JAIF Annual Conference
March 14-16, 1978
Tokyo, Japan

CIVIL NUCLEAR POWER WITHOUT WEAPONS PROLIFERATION

Carl Walske, President
Atomic Industrial Forum, Inc.

My paper is entitled "Civil Nuclear Power Without Weapons Proliferation" in order to emphasize the point that we in the nuclear industry make repeatedly. Civil nuclear power is not synonymous with nuclear weapons.

In fact, for over two decades following President Eisenhower's "Atoms for Peace" initiative, civil nuclear power was very much a positive element in the foreign policy of the United States. By sharing the peaceful atom with other countries we provided an incentive for them to forego the military atom.

Today the situation is somewhat different. The prospects for widespread use of plutonium in civil reactors have raised the spectre of possible misuse. Plutonium intended for peaceful purposes could, in principle, be diverted to use in nuclear weapons. In the United States this fear has led to a reevaluation of old policies and the introduction of new ones. Similar changes are occurring elsewhere.

President Carter's initiatives to slow the spread of new nuclear weapon states have caused many nations to review their policies regarding nuclear exports. At the same time forty nations have joined in an International Nuclear Fuel Cycle Evaluation Program (INFCE), in order to study measures "to minimize the danger of the proliferation of nuclear weapons without jeopardizing energy supplies or the development of nuclear energy for peaceful purposes."

A major step has been taken by the London Nuclear Suppliers Group of fifteen nations in setting guidelines for nuclear transfers. These guidelines -- which are now being placed into effect by each supplier nation acting independently -- require assurances by recipient nations that sensitive technologies and materials will not be used for making nuclear explosives. IAEA safeguards are to be placed on all facilities deriving from or using the transferred materials and technologies. The assurances by the recipient nation do not, however, include a pledge not to produce nuclear explosives in facilities independent of the transferred technologies or materials. Nor do the assurances include the more or less equivalent agreement to place all nuclear facilities in the recipient country under IAEA safeguards, the so-called "full-scope" safeguards.

In the United States the Congress has now passed legislation requiring "full-scope" safeguards as an eventual prerequisite to U.S. nuclear exports. A Presidential signature on the legislation is imminent. There is a grace period provided for implementing this new policy, with extensions possible if the President and Congress agree. Under the legislation the United States will seek to convince other nuclear suppliers to require full-scope safeguards.

The new legislation also seeks to establish control over the enrichment and reprocessing of uranium fuel supplied from the U.S., or of fuel which passes through reactors sold abroad by U.S. firms. Reprocessing, in particular, would not be permitted by the U.S. if it increased the risk of proliferation. Current opinion in the Congres and the Carter Administration is that reprocessing would increase the risk of proliferation if it made separated plutonium available to nations not having it. There is leeway for the U.S. to agree to reprocessing in countries which now have reprocessing plants, subject to U.S. control over the use of the plutonium produced.

The Carter Administration's non-proliferation policy has been described by Dr. Joseph Nye of the U.S. Department of State as six-pronged:

(1) making the international safeguards system more effective by insisting upon comprehensive safeguards;

(2) self-restraint in the transfer of sensitive technologies and materials that can contribute directly to weapons until we have learned to make them more safeguardable;

(3) creation of non-proliferation incentives through fuel assurances and assistance in the management of spent fuel;

(4) building consensus about the future structure and management of the nuclear fuel cycle through studies in the International Nuclear Fuel Cycle Evaluation Program;

(5) taking steps at home to ensure that our domestic nuclear policy was consistent with our international objectives; and last but most important,

(6) taking steps to reduce any security or prestige motives that states might have to develop nuclear explosives.

From the viewpoint of those responsible for the development of civil nuclear power, the new policies, legislation and agreements have much merit, but unfortunately have also done great harm to civil nuclear programs throughout the world. Their impact on public opinion has generally been negative, either arousing unfounded fears associating nuclear power with nuclear weapons, or instilling suspicions of an attempted hegemony by the U.S. and other large nations over nuclear energy.

In the U.S. itself, the programs for utilizing plutonium through reprocessing and the breeder reactor are in total disarray. Plans for future reprocessing plants in Europe and Japan are now subject to the vagaries of U.S. policy since no commitments have yet been made to release fuel of U.S. origin to these plants. Countries with smaller nuclear programs are left uncertain as to whether they will ever receive support from the supplier nations for the use of reprocessing and breeder technologies.

The Risk from Plutonium

In judging the dangers of proliferation we should not equate separated plutonium to nuclear weapons and at the same time label spent LWR fuel free of all risk. The fear has been expressed in some U.S. circles that separated plutonium places a non-nuclear weapon nation only days away from nuclear weapons. The argument is that nuclear weapon assembly systems might be prepared clandestinely and then, when ready, a nation with separated plutonium might quickly insert it into these waiting nuclear weapon assembly systems in a matter of days. Thus, the world would have little warning time in which to react.

This reasoning fails to admit that a fairly simple, clandestine reprocessing plant could also be built, if such secret projects are to be envisaged. In a short time it could produce plutonium from diverted LWR spent fuel. Thus, the separated plutonium is not the controlling factor. The essential in proliferation is motivation; access to materials and technology are secondary.

This scenario, sometimes called "the overnight bomb scenario" also suffers by its exaggeration of the ease with which nuclear weapon assembly systems might be prepared and the ease with which plutonium might be inserted into them.

There are more problems. There is always the possibility of being caught in the act. Further, since the weapon program is covert, it provides little deterrent value until the scheming nation goes overt, i.e., until plutonium is taken from the safeguarded system. It is necessarily an untested weapon capability at least until it comes out of hiding. And it suffers from the handicap of using civil grade plutonium.

Finally and most importantly, the scenario ignores the likely vigorous reaction of the nuclear powers to such a course. One has only to reflect on the concerted reaction recently to reports that South Africa was about to conduct a nuclear weapon test.

All in all, I find the overnight bomb scenario highly contrived and of little use to most nations. Not that it is impossible. It is possible, but still highly contrived and not a very useful approach.

Some have argued also that the mere existence of stockpiles of separated plutonium in non-nuclear-weapon nations provides a temptation. Given some weapons-useable plutonium, so the argument goes, a nation has less remaining to do in order to achieve a nuclear weapon capability. There is perhaps a little more to this argument than to the overnight bomb scenario, but again it is a bit labored.

Despite these arguments the overnight bomb scenario has led us all to reexamine our nuclear programs. In this current, uncertain state of affairs it is now time to address what might be reasonable, negotiable conditions for the civil nuclear world in the year 2000. If we can set out a generally agreed target, perhaps we can better chart our course toward it.

Clearly any realistic target depends primarily on voluntary agreements among sovereign nations. Special inducements may play an important, but secondary, role. Unacceptable restraints imposed on one nation by others may be effective in the short run, but they can be of little use in the long run.

The nuclear world of 2000 must provide an avenue to fulfill the legitimate nuclear power requirements of all nations. Certainly, ways must be found for civil nuclear power projects that make economic sense to proceed.

Technical Ways to Reduce Plutonium Risks

We should consider now that the nuclear world of 2000 will very likely involve the reprocessing of spent uranium fuel and the recycle of recovered plutonium to reactors. Measures to protect this recycled plutonium from misuse will be acceptable provided they give additional protection commensurate with their cost.

An examination of technical means to increase the proliferation resistance of using plutonium soon reveals that they fall into two classes:

(1) Those probably not increasing costs very much, but which are only slightly helpful against national proliferation.

(2) Those which keep high level radiation associated with the plutonium and which would help prevent national proliferation, but at a relatively high cost.

In the first class fall such ideas as: co-locating fuel reprocessing facilities with fuel fabrication facilities in order to make the transportation of plutonium between them more secure; and co-processing plutonium with uranium at a concentration too low for use in nuclear explosives. Both of these ideas would be of considerable value in thwarting subnational groups, such as terrorists, but either of them could easily be defeated by a sovereign nation willing to renounce its international undertakings. On the other hand, both could simplify the task of international inspectors. Thus, while their effectiveness is limited, they appear worth pursuing since their cost is probably low, especially as regards future installations.

The second class of ideas -- those involving keeping plutonium associated with radioactivity -- seek to make the plutonium no more accessible than it is in spent fuel. That is, open access to the plutonium would first require chemical separation in a shielded reprocessing facility. These ideas include modifications to the reprocessing plant so that not all fission products are removed; adding radioisotopes to the separated plutonium, that is, spiking; and irradiating freshly fabricated plutonium-bearing fuel in a special facility before it is shipped. The last two methods do involve a period where the plutonium is fully separated, so they would have to be carried out in a facility which was located in a place judged secure by the international community.

Either spiking or retaining some radioactive fission products with the plutonium requires the remote fabrication of hot fuel and the remote maintenance of the fabrication facility, a costly process. It has been argued that remote operations will be required anyway for the type of highly irradiated plutonium recycled from breeder reactors. If that is so, the remote fabrication and maintenance would not be such a penalty for recycled breeder fuel. Unfortunately, this line of reasoning begs the question, for our first task will be to reprocess the tons of accumulated light water reactor fuel that will exist long before fuel is recycled from breeders. This fuel can be reprocessed best in PUREX plants and its plutonium does not require remote fabrication. By the year 2000 the U.S. alone will have accumulated one hundred thousand tons of spent fuel -- enough to keep a Barnwell-sized reprocessing plant busy for 67 years! The plutonium in that fuel may be about 700,000 kilograms, enough for about 300 LMFBR cores. These numbers will probably be two or three times as large for the entire world. Certainly, the economic incentives will be powerful for handling the plutonium in this fuel efficiently.

The approach using a special irradiation facility has been estimated to add as much as five percent to the cost of generated electricity, again a relatively high cost.

The argument against incurring the cost of hot fuel fabrication, or of providing a special irradiation facility is even stronger. Through the remainder of this century over ninety percent of the spent fuel will be produced in nations where the danger of further proliferation is nil or minimal, and most of the spent fuel will be reprocessed in these same nations. These include the United States, United Kingdom and France which already have nuclear weapons and thus can hardly proliferate. They also include the other nations of western Europe and Japan, which feel comfortable with their existing international political, military and economic relationships, and hence do not seek a nuclear weapons capability. I do not believe that substantial additions to the cost of the fuel cycle -- solely in order to set an example for others -- will prove negotiable with most of these nations, or enforceable, in the long run.

Institutional Ways to Reduce Plutonium Risks

Where I come out on plutonium is that the world should make a good effort to control it, but that in the nuclear world of 2000 we cannot and should not avoid using it. It may be possible to limit the spread of plutonium use for a few years, but ultimately the need for nuclear power -- in particular, the breeder -- will demand that plutonium be used efficiently.

The world could control the spread of plutonium by concentrating its initial use in those nations with major nuclear development programs. If this is accepted by other nations, they should, of course, have access to the technology. In fact, they should be given the opportunity to participate financially and technically.

As breeder and reprocessing technology move forward this same principle of concentration could be followed. Perhaps it is reasonable to ask nations to forego nuclear projects which are not in themselves economic, but which increase the world's concerns over proliferation. These include small scale reprocessing and uranium enrichment plants, which are often desired for prestige purposes or for learning purposes. In exchange for such restraint, personnel from the affected nations could be given experience in commercial-sized reprocessing facilities. In that way the learning purpose of small plants could be alternatively satisfied.

Unfortunately, there seems to be no such sensible course open for enrichment technology which has been kept secret while reprocessing technology was being widely published. It appears that the spread of enrichment facilities will be controlled for many years by keeping the technology secret and by the huge financial resources required to develop and build such plants.

Now I should like to discuss the second major aspect of the new U.S. legislation: the requirement for "full-scope" safeguards as an eventual prerequisite to U.S. nuclear exports. Acceptance of such a requirement by any nation would be tantamount to its pledging not to build nuclear weapons. Some have called it the "poor man's Non-Proliferation Treaty." Of course, the full-scope safeguards approach does not require the categorical statement by a nation that nuclear weapons will not be built, only the pledge that its nuclear facilities will not be used to make nuclear weapons.

Apparently full-scope safeguards were proposed for adoption at meetings of the London Nuclear Suppliers Group. They were not adopted, evidently because of French and German opposition. The French have long followed the policy of not attempting to dictate to other nations that they not build nuclear weapons. This policy is quite understandable when one recollects that the U.S. and Britain strongly opposed the French military nuclear program from its earliest days. This experience has not been forgotten.

There is further merit to the French position. Forcing a nation to renounce nuclear weapons -- before it is really ready to do so -- as a condition for nuclear cooperation, may force that nation into isolation. It may feel compelled to reject the nuclear cooperation in order to maintain its freedom of choice. Having thus been isolated, the political forces advocating a nuclear weapons program can argue that the price has already been paid in terms of lost international cooperation and so the nuclear weapons program should go ahead. South Africa, for example, could be such a country, if it is denied nuclear cooperation from abroad.

A different example is that of Japan. The process of signing and ratifying the NPT took Japan longer than many other nations. The longer period was necessary in order that the issues could be fully aired and a consensus developed. Had Japan been denied access to civil nuclear cooperation during this period perhaps the consensus would not have been reached.

On the other hand, most nations in the world have acceded to the NPT. As of now there are 102 nations which have ratified and an additional 10 have signed. There are perhaps less than ten non-parties which are pursuing civil nuclear power. It can be argued that the world has been patient long enough. Now it is time for these non-parties to renounce nuclear weapons if they are to receive full cooperation from abroad in their nuclear programs. The risk is that if we go such a route we may push one or another of these countries into a nuclear weapons program.

If that were all there were to it, perhaps we would rightly choose patience. Unfortunately, there is more to it. Civil nuclear power cannot afford being tagged with any responsibility for nuclear weapons proliferation. The United States Congress has already imagined such a connection. Many academicians in the U.S. have similarly made such an association. I believe that this feeling will spread to many in other countries unless we take serious action now. Whether the worriers are right or wrong, we must quiet fears that international cooperation in civil nuclear power will feed nuclear weapons proliferation. Such fears, if left to fester, may ultimately have an adverse impact on the domestic programs of the major civil nuclear power nations and on necessary cooperation between them.

The Nuclear World of 2000

At this point I shall discuss the type of arrangements which might prove negotiable for the nuclear power world of 2000. The major principles involved would be:

(1) Primary dependence on cooperation by sovereign nations acting in accordance with their own best interests.

(2) Secondary dependence on inducements by nuclear exporting nations, including the availability of assured supplies of uranium, enrichment services and spent fuel disposal at competitive prices. These inducements would be coupled to an agreement among nuclear exporting nations to require adherence to the NPT or full scope safeguards for importing countries.

(3) General agreement to limit the spread of weapons-useable plutonium and highly enriched uranium to economically justifiable projects. Such projects would include multinational facilities dictated by economy of scale. In general, an effort would be made to limit the number of locations within a single nation where plutonium and highly enriched uranium was present in a weapons-useable form.

(4) Strengthened IAEA safeguards, including continuous international oversight of facilities with weapons-useable plutonium and highly enriched uranium.

(5) General agreement on the need for continued secrecy for uranium isotope enrichment processes.

(6) Agreed international sanctions to be enforced against nations which fail to observe their commitment to forego nuclear weapons, including a cut-off of civil nuclear cooperation.

(7) International cooperation to develop technical approaches which eliminate the restrictive aspects of some of the above principles.

It should be recognized at once that these seven principles alone, if fully carried out, could fall far short of stopping the further proliferation of nuclear weapon states. They address only the relationship of civil nuclear power to this problem. Far more important will be the political efforts, outside the civil nuclear field, to provide nations with sufficient security that their perceived need for nuclear weapons is negated. Attention to the motivations for acquiring nuclear weapons is absolutely essential.

With that last caveat I shall return now to my seven principles and discuss each of them briefly.

The first should hardly need stating. Our world is made up of sovereign nations. Respect for their independence is basic to our world order. Too often, of late, proposals for dealing with the non-proliferation problem have emphasized measures by which one group of nations could control others. This emphasis is fundamentally wrong and, if not eased, it will prove self-defeating. Non-proliferation is a problem to concern all nations. Each should be willing to make some sacrifices in order to control the situation better, but the sacrifices must appeal to the nations concerned. They must be understandable as being necessary, as being effective and as being in the best interests of the nation making the sacrifice. In short, any restrictions on international cooperation in civil nuclear energy must in the long run be voluntarily accepted by the nations affected.

This principle was recognized in the Nuclear Non-Proliferation Treaty, when it was negotiated in the 1960's. The treaty is the existing foundation for cooperation by sovereign nations in civil nuclear energy. Unilateral actions by the United States or actions by the supplier countries that weaken the principle of sovereign cooperation and the NPT regime should be carefully avoided.

The alternative to respecting sovereignty would cause deep-seated resentments. It would emphasize a division of the world into nuclear "haves" and "have-nots." Obviously, the "have-nots" would accept an inferior status only until they had the means to change it. Pressure would be on the "have-nots" to become "haves."

My second principle of inducements also addresses this last point. Inducements can help soften any special sacrifices that are asked of some nations. In particular, adherence to the NPT or the acceptance of full-scope safeguards is a special sacrifice to ask of non-nuclear-weapon nations. Fundamentally, they have as much right to have nuclear weapons as do the United States and the other nuclear weapon nations. The world can ask <u>them</u> to forego nuclear weapons, because <u>only they</u> have already foregone nuclear weapons. It is hardly fair; but it is pragmatic.

As some compensation for such a sacrifice, the nuclear-weapon nations and other nuclear supplier nations must offer what they can in inducements. The nuclear-weapon nations must do much more than they have so far to slow the arms race, to reduce tensions and to begin the elimination of nuclear weapon stockpiles. On the civil side, to which I am generally limiting my remarks, the supplier nations must make available assured supplies of uranium and enrichment services to other nations which are cooperating in combatting proliferation. Assurance of supply means diversity of suppliers and it also means competitive and fair prices. There may be added assurance in establishing internationally controlled "banks" with stockpiles of enriched uranium, but only if there is not sufficient diversity of supply available from independent exporters.

As regards the back end of the fuel cycle the supplier nations shou be helpful to others in disposing of their spent fuel. If spent fuel is to be reprocessed and use made of the recovered unburnt uranium and plutonium -- as I believe must be the case -- then satisfactory arrangements must be made for the disposition of the plutonium. If the plutonium is not to be returned, just compensation must be paid for it in fresh fuel or money.

The radioactive wastes, too, present an opportunity for inducements. If the nations with reprocessing plants can arrange to dispose of the radioactive wastes, as opposed to returning them to the country originating them, this could be a powerful inducement to accept reprocessing abroad. My feeling is that the disposal of radioactive wastes -- now so much a problem -- will some day be a sought after business. The problems today are much more political and emotional than they are technical. Once these are overcome, the storage of radioactive waste will become commonplace.

The imposition of export controls is, of course, affected by the distribution of essential supplies. In 1977 some 64 percent of uranium outside the Soviet Union came from the United States, Canada, and Australia; by 1990, when the NEA/IAEA estimate more than three times as much production, these three countries will be producing about 71 percent of the available uranium. Obviously, their export policies -- if they are concerted -- will be of great importance, but there will be by that time very large quantities outside their control. The non-Soviet uranium production not under their control will almost triple between now and 1990. Most of this will be from Africa.

Similarly in the enrichment area the U.S. share of the non-Soviet bloc market is currently about 85 percent; however, this will fall to about 50 percent by 1990. Plans are underway in Europe and Japan to provide very significant amounts of enrichment capacity in the nineties. One very strong motivation for some of these new plants was to escape domination by United States policymakers.

LWR technology itself, and even reprocessing technology, is available openly in its main essentials. As time goes by experience in using these technologies will be very widespread.

Consequently, I argue that the leverage available to nuclear exporting countries through control of their exports will decrease markedly in the coming years. This re-emphasizes the need for voluntary cooperation and the need for real inducements to offset any sacrifices.

My third point is general agreement that weapons-useable materials should be limited to economically justifiable projects. The first measure of economy is one of scale. In order for a reprocessing plant to be economic it must be large -- and hence involve a large capital expenditure. A plant capable of reprocessing fuel from 50 reactors of 1000 MWe would be economic; one a tenth that size would not. Such a large plant can be justified either to serve a large domestic market or to serve a number of nations which cumulatively have a large bloc of nuclear power.

The latter suggests the practicality of some multinational reprocessing facilities. Initially such facilities might be located in North America, Europe or Japan, where there currently is considerable experience and, of course, the major nuclear power programs. Later South America and the Middle East would seem appropriate locations. Still others later.

By multinational I have in mind, as a minimum, multinational sharing in the reprocessing services. There would be additional security for some nations if such a facility were multinationally financed and owned. A more radical idea -- but one I believe is necessary -- is to open such facilities, and for that matter purely national facilities, to the technicians from countries which are postponing their own facilities to a later day in the interest of simplifying the problems of world oversight. Such a policy could eliminate the need for pilot-sized or demonstration-sized reprocessing plants. Technicians could go abroad to learn at first hand in a full-scale plant.

By thus limiting the spread of facilities where plutonium was handled in a weapon-useable form, there would be fewer nations and locations where international oversight was required. This not only has the practical value of reducing the task of the IAEA which should provide continuous oversight, but it has the valuable psychological advantage of making oversight seem more manageable.

These restrictions on the number of locations should similarly be applicable within a single nation and they should include serious efforts to co-locate fabrication facilities for plutonium bearing fuel with reprocessing facilities. This last step will also serve to reduce the transportation of weapons-useable plutonium in a form free of extra radioactivity.

My advocacy of strengthened IAEA safeguards, point number four, has been widely accepted in principle. Its implementation will take some doing, but there is a general will to make improvements. IAEA inspections must be made less dependent on the whims of the inspected country. There must also be a clear understanding that any violations will promptly be reported to the international community.

For the near term the cost of enrichment plants and the difficulty of independently mastering the necessary technology will serve to retard their spread. In the longer term arrangements analogous to those for reprocessing plants will be necessary. When the technology for small-sized laser or centrifuge plants becomes openly available that will present an immense problem. If the enrichment technology is kept secret this day can be delayed for many years and so I advocate doing so in my fifth point. If we succeed in setting up political and institutional arrangements for managing plutonium in the near future, perhaps this experience will provide the momentum for limiting the spread of uranium enrichment facilities.

It is evident to all that the availability to all nations of competitive and diversified enrichment services at the lowest possible, fair prices will go a long way toward slowing the spread of enrichment plants.

My sixth point is agreed international sanctions against violators of undertakings to forego nuclear weapons. A cut-off of civil nuclear cooperation could probably be agreed as a prime sanction. A loss of uranium or enrichment supplies could have an immense economic impact. Beyond this, even further sanctions are probably advisable, but they will be difficult to negotiate. One idea is for some of the larger nations to announce now the sanctions which they will take independently in the event of a violation. Further than this, the area of private, bilateral communication may prove very useful in spelling out the serious consequences of breaking a commitment to forego nuclear weapons. According to press reports bilateral communications already have been effective in several cases.

My seventh and last point is for all nations to cooperate in developing technical approaches which eliminate the restrictive aspects of some of my earlier principles. While it would be ideal to have economically acceptable technical solutions in hand right now, we simply do not. We shall have to proceed with some agreed restrictions and hope for an easing later.

Given sufficient time there is some hope of reducing restrictions. I have already mentioned that keeping radioactivity associated with plutonium at all times -- with its attendant hot fabrication of new fuel elements -- may be little or no penalty with recycled fast breeder fuel. Similarly, the eventual development of thorium converting reactors, producing U-233 which may be denatured in natural uranium, may give us added flexibility.

Please note that in advocating technical developments to ease non-proliferation restrictions, I have not proposed delaying the development of the breeder or of the necessary reprocessing plants to go with it. In the first place, I don't believe that is a negotiable approach. In the second place, I believe it would be terribly wrong considering the world's acute need for the breeder in just a few years.

Conclusion

Summing up, my first main point in this paper is that while much progress has already been made in controlling the peaceful atom, new requirements are emerging from policymakers in the United States and elsewhere. In effect, the United States is now asking nuclear importers to renounce nuclear weapons as the price of further civil nuclear cooperation. Other supplier nations will have to reexamine their own policies in this regard.

Perhaps such a requirement for importers -- that is, adherence to the NPT or the acceptance of full-scope safeguards -- is now negotiable. There are pros and cons in forcing it on unwilling nations, still there is now an urgent need to reassure people everywhere that major efforts are being made to keep the peaceful atom peaceful.

A second United States objective is to discourage the use of plutonium free from radioactivity. This objective seems hardly negotiable among the major nuclear power nations, considering the immense need for reprocessing spent LWR fuel, and for the LMFBR and its attendant recycling of generated plutonium.

The fear of separated plutonium from civil reactors, I have argued, is exaggerated. At the same time I have advocated doing more than we now do to control its spread. Principally, I have proposed limiting its use to situations that are economically attractive. In compensation, personnel from nations with presently small nuclear power programs could share in reprocessing and breeder experiences abroad. Further, competitive and fairly priced fuel cycle supplies and services should be offered to such nations. In the long run their voluntary support is absolutely necessary if we are to have a stable and peaceful nuclear situation in the world.

Overall, my general proposition is respect for each nation's sovereign rights and respect for each nation's legitimate energy needs. Nothing less will succeed.

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Remarks By
Commissioner Richard T. Kennedy
U.S. Nuclear Regulatory Commission
Before The
Japan Atomic Industrial Forum Annual Conference
Tokyo, Japan
March 14, 1978

U.S. NONPROLIFERATION POLICY: A REGULATORY PERSPECTIVE

I am pleased to have this opportunity to meet with you this afternoon. The invitation which the Japan Atomic Energy Commission and the Atomic Industrial Forum of Japan extended to me is a great honor indeed and one which I deeply appreciate. The timing of this session is particularly fortuitous, coming as it does within days of President Carter's signature into law of the Nuclear Nonproliferation Act of 1978.

The theme for this session -- "Atomic Energy Development and Its International Perspectives" -- focuses on some of the key issues facing energy planners throughout the world. For on the future of atomic energy will depend much of the world's economic strength, at least through the end of this century.

Of the many and varied international perspectives on nuclear energy development, the one which has come to dominate much

OF THE ATTENTION OF INDUSTRY, GOVERNMENTS, AND PEOPLE ALIKE IS THE POTENTIAL PROLIFERATION RISK. SOME FEAR THAT THIS RISK WILL GROW AS AN INEVITABLE CONSEQUENCE OF THE WIDESPREAD USE OF NUCLEAR ENERGY.

FOR THOSE OF US WHO BELIEVE THIS ENERGY SOURCE WILL BE AN INCREASINGLY SIGNIFICANT COMPONENT OF THE WORLD'S ENERGY SUPPLY, THE CHALLENGE OF CONTAINING POSSIBLE PROLIFERATION RISKS MUST BE MET. BUT TO DO SO WILL INVOLVE NOT ONLY LONG-RANGE POLITICAL AND INSTITUTIONAL INITIATIVES, BUT ALSO MORE IMMEDIATE TECHNICAL MEASURES. FOR UNLESS WE ARE SUCCESSFUL IN ALLEVIATING THE CONCERNS VOICED BY MANY IN THE PUBLIC OVER THE POSSIBLE DANGERS OF THE EXPANDED USE OF NUCLEAR ENERGY, ITS CONTINUED USE AS A SOURCE OF ENERGY, HOWEVER MUCH IT MAY BE NEEDED, WILL BE UNCERTAIN AT BEST.

IN THAT LIGHT, THEN, I WOULD LIKE TO TAKE A FEW MINUTES TODAY TO REVIEW WITH YOU THE CURRENT THRUST OF UNITED STATES NONPROLIFERATION POLICY. IN DOING SO, I WILL FOCUS ON THREE BROAD ASPECTS OF THAT POLICY:

- -- MODIFICATIONS WE HAVE MADE IN OUR DOMESTIC NUCLEAR PROGRAM;
- -- INTERNATIONAL INITIATIVES, NOTABLY THE INTERNATIONAL NUCLEAR FUEL CYCLE EVALUATION; AND

-- CHANGES IN OUR NUCLEAR TRADING RELATIONS WITH OTHER NATIONS RESULTING FROM PASSAGE OF THE NEW NONPROLIFERATION LEGISLATION.

WHEN THE CARTER ADMINISTRATION TOOK OFFICE A LITTLE OVER A YEAR AGO, IT SAW THE PROBLEMS OF MEETING THE ENERGY NEEDS OF THE UNITED STATES, AND INDEED THE WORLD AS A WHOLE, AS ONE OF THE FOREMOST ISSUES BEFORE IT. NUCLEAR ENERGY CLEARLY HAD AN IMPORTANT ROLE TO PLAY BUT WAS INCREASINGLY AT THE CENTER OF HEATED CONTROVERSY. A KEY QUESTION THEN WAS HOW TO MAKE NUCLEAR POWER AVAILABLE TO MEET WORLD ENERGY NEEDS WITHOUT SIMULTANEOUSLY ACCELERATING THE SPREAD OF NUCLEAR WEAPONS CAPABILITIES. THE ADMINISTRATION, THEREFORE, UNDERTOOK A STUDY ON AN URGENT BASIS, USING THE MANY STUDIES AND REVIEWS DONE OVER THE PRECEDING TWO OR THREE YEARS, AS A PLATFORM, TO FOCUS THE ISSUES AND TO SEEK POTENTIAL SOLUTIONS.

WHAT FOLLOWED IS HISTORY WELL KNOWN TO ALL OF YOU. ON APRIL 7 LAST YEAR, PRESIDENT CARTER OUTLINED HIS NUCLEAR ENERGY POLICY. HE REITERATED THE GROWING CONCERN OVER THE PROSPECTS FOR WEAPONS PROLIFERATION, AND HE SINGLED OUT, AS A SPECIAL SOURCE OF CONCERN, THE POTENTIAL SPREAD OF SENSITIVE ENRICHMENT AND REPROCESSING FACILITIES WHICH COULD PROVIDE ACCESS TO WEAPONS USABLE MATERIAL.

To meet the challenge posed by plutonium and related technologies, the President announced a major change in U.S. domestic nuclear energy policy and programs. At the same time he called for a concerted effort among all nations to find better answers to the problems and risks accompanying the increased use of nuclear power.

The Administration adopted a strategy which included six elements: (1) (l) making the international safeguards system more effective by insisting upon comprehensive safeguards; (2) exercising self-restraint in the transfer of sensitive technologies and material that can contribute directly to weapons until we have learned to make them more safeguardable; (3) creating nonproliferation incentives through fuel assurances and assistance in the management of spent fuel; (4) building consensus about the future structure and management of the nuclear fuel cycle through studies in the International Nuclear Fuel Cycle Evaluation that first convened in Washington in October; (5) taking steps at home to ensure that our domestic nuclear policy was consistent with our international objectives; and (6) taking steps to reduce any security or prestige reasons that might impel states to develop nuclear explosives.

WHEN THE POLICY WAS FIRST ARTICULATED A YEAR AGO, SOME INTERPRETED IT AS BEING ANTI-NUCLEAR. THIS IS SIMPLY NOT THE CASE.

IN HIS APRIL STATEMENT, THE PRESIDENT SPECIFICALLY RECOGNIZED THAT MANY NATIONS SEE NUCLEAR POWER AS THE ONLY REAL OPPORTUNITY TO REDUCE THEIR DEPENDENCE ON IMPORTED OIL. HE TERMED THE BENEFITS OF NUCLEAR POWER "VERY REAL AND PRACTICAL." I SHOULD NOTE THAT HE RECENTLY REITERATED THOSE VIEWS ON THE FUTURE OF NUCLEAR ENERGY. HE OBSERVED THAT, AFTER ALL OTHER POSSIBLE ENERGY SOURCES ARE EXPLORED, THERE IS STILL A NEED IN THE FORESEEABLE FUTURE FOR NUCLEAR POWER. AND HE ADDED THAT THE SAFETY RECORD OF OUR NUCLEAR POWER PLANTS IS FAR BETTER THAN THE SAFETY RECORD OF POWER PLANTS THAT ARE FUELED BY OIL OR COAL.

WHAT THE ADMINISTRATION'S POLICY SEEKS IS AN INTERNATIONAL CONSENSUS ON THE DESIRABILITY OF THE FURTHER SPREAD OF NUCLEAR WEAPONS AND ON THE NATURE AND MANAGEMENT OF THE FUEL CYCLE. THE PRESIDENT'S POSITION ON SENSITIVE FACILITIES WAS BASED ON HIS BELIEF THAT THERE IS STILL TIME TO EXPLORE THE TECHNICAL AND ECONOMIC FEASIBILITY OF ALTERNATIVE FUEL CYCLES WHICH ARE MORE PROLIFERATION RESISTANT. THUS, IN OUR

OWN NUCLEAR POWER PROGRAM WE HAVE DEFERRED COMMERCIAL REPROCESSING AND PLUTONIUM RECYCLE AND HAVE RESTRUCTURED OUR FAST BREEDER PROGRAM.

THE RECENT ORDER OF THE NUCLEAR REGULATORY COMMISSION ON THE GENERIC ENVIRONMENTAL STATEMENT ON MIXED OXIDE FUEL -- THE SO CALLED GESMO -- IS CONSISTENT WITH THIS POLICY. THAT ORDER ANNOUNCED OUR DECISION TO TERMINATE THE FOUR YEAR REVIEW OF THE HEALTH, SAFETY, SAFEGUARDS, AND ENVIRONMENTAL IMPACTS ASSOCIATED WITH PLUTONIUM RECYCLE IN THE UNITED STATES.

ONE FACTOR IN THE COMMISSION DECISION WAS THE PRESIDENT'S VIEW THAT HIS NONPROLIFERATION INITIATIVES WOULD BE ASSISTED BOTH DOMESTICALLY AND INTERNATIONALLY IF THE COMMISSION WERE TO TERMINATE RECYCLE-RELATED PROCEEDINGS. PERSONALLY I WOULD HAVE PREFERRED USING A TERM SUCH AS "DEFER" RATHER THAN "TERMINATE." THIS WOULD HAVE GIVEN OUR ACTION ~~A~~ LESS~~ER~~ OF A TONE OF FINALITY. NONETHELESS, THE PRACTICAL EFFECT OF OUR DECISION IS THE SAME. WE WILL EXAMINE THE ISSUES AGAIN IN APPROXIMATELY TWO YEARS WHEN THE RESULTS OF THE ALTERNATIVE FUEL CYCLE STUDIES ARE AVAILABLE. MEANWHILE WE WILL PUBLISH FOR REFERENCE PURPOSES THE NRC STAFF STUDIES WHICH WERE DONE TO SUPPORT THE GESMO PROCEEDING.

OUR POLICY ON FAST BREEDER DEVELOPMENT ALSO WAS MISUNDERSTOOD IN SOME QUARTERS. SIMPLY STATED, THE U.S. OPPOSES PREMATURE MOVEMENT TOWARD A BREEDER ECONOMY WHERE THE PRESENCE OF DIRECTLY WEAPONS-USABLE MATERIAL WOULD BE WIDESPREAD. BUT I WOULD STRESS THAT, CONTRARY TO WHAT SOME BELIEVE, WE HAVE NOT SUGGESTED A MORATORIUM ON THE BREEDER PROGRAMS OF OTHER NATIONS. WE FULLY RECOGNIZE THAT MANY NATIONS ARE FAR MORE DEPENDENT ON ENERGY IMPORTS THAN WE, AND THAT THEIR PROBLEMS AND PERSPECTIVES THEREFORE ARE DIFFERENT. WE BELIEVE, HOWEVER, THAT THERE IS TIME TO REVIEW THE FUEL CYCLE ALTERNATIVES TO FIND MORE PROLIFERATION PROOF MEANS BEFORE COMMERCIAL USE OF THE BREEDER WILL BE NEEDED. PRESIDENT CARTER PUT IT THIS WAY, "I HAVE NO OBJECTION TO BREEDER REACTORS. I DON'T THINK THEIR TIME HAS YET COME." INDEED, WE ARE SPENDING IN THIS FISCAL YEAR ALONE NEARLY $400 MILLION ON OUR OWN BREEDER RESEARCH EVEN THOUGH STEPS TOWARD EARLY COMMERCIALIZATION HAVE BEEN HALTED.

THE U.S. POLICY WAS FORGED WITH FULL RECOGNITION THAT TO BE SUCCESSFUL IT ALSO MUST MAKE PROVISION FOR ASSURED NUCLEAR FUEL SUPPLIES. ONLY THEN WOULD THE MOTIVATION TO ACQUIRE SENSITIVE FACILITIES BE DIMINISHED. THUS WE HAD TO TAKE STEPS TO ASSURE A SUPPLY OF NONSENSITIVE NUCLEAR FUELS ON A TIMELY AND ECONOMIC BASIS AT THE FRONT END OF THE FUEL CYCLE AND, AT THE SAME TIME, ASSURE SUFFICIENT STORAGE CAPACITY FOR SPENT FUEL AND NUCLEAR WASTE AT THE BACK END.

TO THIS END, THE U.S. HAS TAKEN A NUMBER OF ACTIONS.

- U.S. ENRICHMENT CAPACITY IS TO BE INCREASED;
- THE PRESIDENT HAS CALLED FOR THE ESTABLISHMENT OF AN INTERNATIONAL FUEL BANK; AND
- WE HAVE INDICATED A WILLINGNESS TO TAKE BACK LIMITED QUANTITIES OF SPENT FUEL FROM OTHER COUNTRIES WHERE THIS WOULD SUPPORT OUR NONPROLIFERATION OBJECTIVES.

ON THE INTERNATIONAL SCENE, PRESIDENT CARTER CALLED FOR AN INTERNATIONAL NUCLEAR FUEL CYCLE EVALUATION. THE RESPONSE WAS DRAMATIC. FORTY-FOUR NATIONS ARE PARTICIPATING IN AN EXAMINATION OF ALL ASPECTS OF THE NUCLEAR FUEL CYCLE. EIGHT WORKING GROUPS DEALING WITH URANIUM AVAILABILITY, ENRICHMENT CAPACITY, REPROCESSING AND BREEDER ALTERNATIVES, SPENT FUEL AND WASTE DISPOSAL, AND ADVANCED REACTOR FUEL CYCLE CONCEPTS ARE OFF TO A GOOD START. AND, MAY I SAY AT THIS JUNCTURE, HOW MUCH WE WELCOME THE CONTRIBUTION JAPAN HAS ALREADY MADE TO THIS ENTERPRISE, PARTICULARLY THROUGH ITS CO-CHAIRMANSHIP OF THE REPROCESSING WORKING GROUP.

OUR OBJECTIVE IS NOT TO SOLVE ALL OF THE WORLD'S NUCLEAR ENERGY PROBLEMS, BUT RATHER TO FIND, AS ONE OBSERVER PUT IT,

"COMBINATIONS OF TIME, TECHNOLOGY, AND INSTITUTIONS THAT CAN PRODUCE A MORE SAFEGUARDABLE FUEL CYCLE." WE ARE SEEKING ALTERNATIVES TO AN ECONOMY BASED ON THE SEPARATION OF PURE PLUTONIUM OR THE PRESENCE OF HIGHLY ENRICHED URANIUM, METHODS TO DEAL WITH SPENT FUEL STORAGE, AND METHODS TO IMPROVE THE SAFEGUARDS FOR EXISTING NUCLEAR TECHNOLOGY. FOR OUR PART, WE VIEW THIS EFFORT AS A TRULY INTERNATIONAL ENTERPRISE AND ARE APPROACHING IT WITH AN OPEN MIND AS TO ITS CONCLUSIONS.

IT IS AGAINST THIS BACKDROP THAT THE DEBATE OVER NONPROLIFERATION LEGISLATION PROCEEDED IN THE UNITED STATES FOR NEARLY TWO YEARS. THROUGHOUT THE DIFFICULT NEGOTIATIONS ON THE PROPOSED LEGISLATION WITH BOTH HOUSES OF THE CONGRESS, PROVISIONS WHICH MIGHT HAVE LED TO A DE FACTO MORATORIUM ON U.S. NUCLEAR EXPORTS WERE VIGOROUSLY OPPOSED BY THE ADMINISTRATION. FOR IT WAS WELL RECOGNIZED THAT IF THE NEW NUCLEAR POLICY WAS TO HAVE A CHANCE OF SUCCESS, OUR REPUTATION AS A RELIABLE SUPPLIER OF NUCLEAR MATERIAL AND FUEL MUST BE RETAINED AND ENHANCED. AND IT WAS EQUALLY WELL RECOGNIZED THAT THE INTERNATIONAL SAFEGUARDS REGIME MUST BE STRENGTHENED. OFTEN CONFLICTING GOALS MADE FINAL DRAFTING AN UNUSUALLY DIFFICULT CHORE. HOW SUCCESSFUL THE RESULT HAS BEEN REMAINS TO BE SEEN, AS THERE ARE CERTAIN PROVISIONS OF THE ACT WHICH CLEARLY WILL NEED CONSIDERABLE CARE IN IMPLEMENTATION.

LET ME DISCUSS FOR A MOMENT A FEW OF THE MORE SIGNIFICANT FEATURES OF THIS NEW LAW -- THE NUCLEAR NONPROLIFERATION ACT OF 1978.

REFLECTING THE DEEP AND WIDESPREAD CONCERN OVER THE PROLIFERATION IMPLICATIONS OF SENSITIVE TECHNOLOGIES TO WHICH I HAVE ALLUDED, THE ACT ESTABLISHES NEW CONTROLS OVER ENRICHMENT, REPROCESSING, AND THE TRANSFER OF SENSITIVE NUCLEAR TECHNOLOGY. THE ACT PROHIBITS THE EXPORT OF MAJOR COMPONENTS OF ENRICHMENT, REPROCESSING, AND HEAVY WATER FACILITIES, UNLESS AN AGREEMENT FOR COOPERATION SPECIFICALLY DESIGNATES SUCH COMPONENTS AS ITEMS TO BE EXPORTED. MOREOVER, U.S. SUPPLIED MATERIAL MAY NOT BE ENRICHED AFTER IT HAS LEFT THE UNITED STATES UNLESS THE U.S. HAS GIVEN PRIOR APPROVAL.

AS TO REPROCESSING, U.S. CONSENT TO RETRANSFERS FOR THAT PURPOSE MAY BE GIVEN ONLY IF THERE WILL NOT BE A SIGNIFICANT INCREASE IN THE RISK OF PROLIFERATION. FOREMOST CONSIDERATION WILL BE GIVEN TO WHETHER THE REPROCESSING OR RETRANSFER WILL TAKE PLACE UNDER CONDITIONS THAT WILL ENSURE TIMELY WARNING OF ANY DIVERSION. AN EXCEPTION TO THIS STANDARD IS MADE FOR REPROCESSING AT FACILITIES THAT HAVE PROCESSED POWER REACTOR FUEL ASSEMBLIES PRIOR TO THE DATE OF THE LAW. BUT EVEN IN

THESE CASES, CONGRESS MADE IT CLEAR THAT EFFORTS SHOULD BE MADE TO ASSURE, WHERE POSSIBLE, THE SAME TIMELY WARNING STANDARD.

THE ACT ALSO SETS OUT STRINGENT NEW REQUIREMENTS THAT MUST BE INCORPORATED IN NEW OR AMENDED AGREEMENTS FOR COOPERATION. NEW AGREEMENTS, FOR EXAMPLE, MUST PROVIDE FOR U.S. APPROVAL RIGHTS OVER BOTH THE RETRANSFER AND THE REPROCESSING OF U.S.-SUPPLIED MATERIAL OR MATERIAL PRODUCED FROM IT, AND FOR GUARANTEES COVERING THE TRANSFER OF SENSITIVE NUCLEAR TECHNOLOGY. IN ORDER TO ASSURE THE PROPER PROTECTION OF MATERIALS, THE NEW AGREEMENTS MUST ALSO PROVIDE FOR ADEQUATE PHYSICAL SECURITY ARRANGEMENTS AND FOR APPROVAL RIGHTS OVER THE STORAGE OF PLUTONIUM AND HIGHLY ENRICHED URANIUM SUPPLIED BY THE U.S. OR RECOVERED FROM MATERIAL OR REACTORS SUPPLIED BY THE U.S.

AS TO NUCLEAR WEAPONS, NEW AGREEMENTS ALSO MUST PROVIDE FOR GUARANTEES THAT A NATION RECEIVING U.S. NUCLEAR MATERIALS WILL NOT USE THEM TO PRODUCE A NUCLEAR EXPLOSIVE DEVICE; AND THE AGREEMENTS ALSO MUST PROVIDE FOR SANCTIONS IN CASE THE RECIPIENT NATION EITHER DETONATES SUCH A DEVICE OR TERMINATES OR ABROGATES AN IAEA SAFEGUARDS AGREEMENT. PERHAPS THE MOST IMPORTANT, AND LIKELY MOST CONTROVERSIAL, REQUIREMENT IS

THAT NEW AGREEMENTS FOR COOPERATION MUST PROVIDE FOR FULL FUEL-CYCLE SAFEGUARDS -- IN OTHER WORDS, SAFEGUARDS MUST BE APPLIED NOT ONLY TO U.S.-SUPPLIED MATERIAL AND FACILITIES AND MATERIAL DERIVED THEREFROM, BUT ALSO TO ALL PEACEFUL NUCLEAR ACTIVITIES IN A NON-NUCLEAR WEAPON STATE.

ONE OR MORE OF THE MANY REQUIREMENTS MAY BE WAIVED BY THE PRESIDENT. THE LIKELIHOOD OF FREQUENT WAIVERS I SUSPECT WILL BE REMOTE, HOWEVER, BECAUSE OF THE NEED TO MAKE THIS A UNIFORM NONDISCRIMINATORY POLICY. ANY PRESIDENTIAL WAIVER, I SHOULD NOTE, WOULD BE SUBJECT TO REVIEW BY CONGRESS.

THE LAW ALSO DIRECTS THE PRESIDENT TO INITIATE A PROGRAM IMMEDIATELY TO RENEGOTIATE EXISTING AGREEMENTS FOR COOPERATION IN ORDER TO INCORPORATE IN THEM PROVISIONS THAT WOULD BE REQUIRED IN NEW AGREEMENTS.

IN DEVELOPING THIS LEGISLATION, BOTH THE CARTER ADMINISTRATION AND THE CONGRESS RECOGNIZED THE NEED TO BALANCE THE CONSTRAINT AND CONTROL PROVISIONS OF THE LEGISLATION WITH A PROGRAM OF INCENTIVES DESIGNED TO MAKE THE U.S. AN ATTRACTIVE AND RESPONSIBLE NUCLEAR SUPPLIER. TO THIS END, THE ACT DIRECTS THE SECRETARY OF ENERGY TO PROCEED WITH THE CONSTRUCTION AND OPERATION OF EXPANDED URANIUM ENRICHMENT CAPACITY AND TO

DEVELOP INTERNATIONAL APPROACHES TO MEETING FUTURE WORLDWIDE NUCLEAR NEEDS. THESE WOULD INCLUDE AN INTERNATIONAL FUEL AUTHORITY WHICH COULD PROVIDE FUEL SERVICES AND ESTABLISH REPOSITORIES FOR STORAGE OF SPENT NUCLEAR FUEL. THE PRESIDENT IS ALSO DIRECTED TO REPORT TO THE CONGRESS ON THE DESIRABILITY OF INVITING FOREIGN PARTICIPATION IN NEW U.S. URANIUM ENRICHMENT FACILITIES. I EMPHASIZE, HOWEVER, THAT THESE FUEL ASSURANCES WOULD BE FOR COUNTRIES THAT ADHERE TO POLICIES DESIGNED TO PREVENT PROLIFERATION.

PERHAPS THE REAL KEYSTONE OF THE NEW LAW IS THE SET OF SIX NEW EXPORT LICENSING CRITERIA WHICH WILL BE IMMEDIATELY APPLICABLE TO ALL NUCLEAR EXPORTS. BEFORE AUTHORIZING AN EXPORT THE NUCLEAR REGULATORY COMMISSION MUST FIND, BASED ON A REASONABLE JUDGMENT OF THE ASSURANCES PROVIDED AND OTHER INFORMATION AVAILABLE TO THE U.S. GOVERNMENT, THAT SIX CRITERIA OR THEIR EQUIVALENT ARE MET:

1. IAEA SAFEGUARDS MUST BE APPLIED TO EXPORTED ITEMS.
2. NO EXPORT MAY BE USED TO DEVELOP ANY NUCLEAR EXPLOSIVE DEVICE, INCLUDING SO-CALLED PEACEFUL NUCLEAR EXPLOSIVES.

3. Adequate physical security must be maintained. The word "adequate" is used because certain nuclear exports are not sufficiently important to present any problem in the event of theft or sabotage;

4. No export may be retransferred without the prior approval of the United States, and no such approvals may be granted unless the third party agrees to adhere to all the new export criteria.

5. No exported material may be reprocessed or altered in form or content without prior U.S. approval.

6. The foregoing must be applied to any nuclear material or equipment produced or constructed through the use of any sensitive nuclear technology which is exported from the United States.

These six criteria, which are now in effect, will be supplemented by an additional requirement to take effect after eighteen months. At that time, IAEA must apply safeguards to all recipient country's peaceful nuclear activities at the time of the export. This will not require a pledge that full-scope safeguards will be maintained indefinitely into the

FUTURE, AS IS REQUIRED UNDER THE NONPROLIFERATION TREATY, BUT RATHER, THAT ALL EXISTING PEACEFUL NUCLEAR ACTIVITIES ARE SAFEGUARDED AT THE TIME OF THE EXPORT. UNDER EXTRAORDINARY CIRCUMSTANCES, AND SUBJECT TO CONGRESSIONAL REVIEW, THE PRESIDENT MAY WAIVE THIS CRITERION IF HE DETERMINES THAT FAILURE TO APPROVE AN EXPORT WOULD SERIOUSLY PREJUDICE UNITED STATES NONPROLIFERATION OBJECTIVES OR WOULD OTHERWISE JEOPARDIZE THE COMMON DEFENSE AND SECURITY.

IT IS EVIDENT FROM WHAT I HAVE SAID THAT THIS NEW LAW HAS GIVEN MAJOR NEW RESPONSIBILITIES TO THE NUCLEAR REGULATORY COMMISSION. WHEN ONE SPEAKS OF A REGULATORY AGENCY, ONE NORMALLY THINKS OF DOMESTIC REGULATION. INDEED, THE COMMISSION DOES HAVE EXCLUSIVE REGULATORY JURISDICTION OVER THE CIVIL USES OF NUCLEAR ENERGY IN THE UNITED STATES. BUT IT ALSO IS RESPONSIBLE FOR LICENSING EXPORTS OF NUCLEAR MATERIALS AND FACILITIES. OUR DOMESTIC HEALTH AND SAFETY RESPONSIBILITIES ARE GOVERNED BY A STRINGENT REGULATORY FRAMEWORK. BUT IN EXPORT MATTERS, THE RANGE OF OUR CONSIDERATIONS GOES WELL BEYOND ANY SINGLE FRAMEWORK AND ENTAILS JUDGMENTS ON A VARIETY OF FACTORS.

In looking at the Commission's responsibilities, it is important to recognize that the NRC is an independent agency of our government. It is not directly responsible to the President. Our judgments are ours alone to make. We are guided, but not governed, by the President's policy.

The new nonproliferation legislation specifies the criteria which must be met before an export can be approved. But the Commission is also required by law to find that the export will not be inimical to the common defense and security of the United States; that is, it will not damage important U.S. interests. In making this finding, the Commission must consider matter which inevitably will involve our foreign relations. In other words, the Commission must also take into account the broader international framework in which the particular export will take place. In doing so, we must rely heavily on the recommendations of the State Department and other agencies ~~who~~ WHICH are directly responsible to the President. For it is the President who has primary responsibility for the conduct of our foreign relations. For us to do otherwise would place the NRC in a position to take actions on its own in matters affecting our foreign policy, separate and apart from the actions of the President. This, in my view, would be an undesirable if not an untenable position.

UNTIL NOW THE COMMISSION HAS HAD THE FINAL SAY ON ANY GIVEN EXPORT. NOT EVEN THE PRESIDENT COULD OVERRULE A NEGATIVE DECISION ON OUR PART. UNDER THE NEW LAW, HOWEVER, IF THE NRC DECIDES NOT TO ISSUE A LICENSE THE PRESIDENT HAS THE AUTHORITY TO REVERSE THAT DECISION. TO DO SO, HOWEVER, HE AGAIN MUST FIND THAT WITHHOLDING THE EXPORT WOULD SERIOUSLY PREJUDICE THE ACHIEVEMENT OF UNITED STATES' NONPROLIFERATION OBJECTIVES, OR WOULD OTHERWISE JEOPARDIZE THE COMMON DEFENSE AND SECURITY. IF THE PRESIDENT WERE TO REVERSE AN NRC DECISION IN THIS WAY, HIS ACTION WOULD BE SUBJECT TO REVIEW BY CONGRESS.

THIS NEW AUTHORITY FOR THE PRESIDENT SIMPLY RECOGNIZES THAT THE FINAL DECISION SHOULD BE HIS IN CASES WHERE HE BELIEVES THE COMMISSION'S VIEW TO BE INCOMPATIBLE WITH THE ESSENTIAL FOREIGN POLICY OR NATIONAL SECURITY POLICY OBJECTIVES OF THE UNITED STATES. I WOULD ADD THAT THE COMMISSION FULLY SUPPORTED THIS PROVISION.

THE NEW LAW ALSO EMPHASIZES THE IMPORTANCE OF EXPEDITING THE EXPORT LICENSING PROCESS. INDEED, IT DIRECTS THE COMMISSION TO DEVELOP PROCEDURES WHICH WILL ASSURE THAT EXPORT LICENSES WILL BE PROCESSED QUICKLY. THE STATE DEPARTMENT AND OTHER

AGENCIES ARE REQUIRED TO PROVIDE THEIR JUDGMENTS TO THE NRC ON A PENDING LICENSE WITHIN SIXTY DAYS, UNLESS THE SECRETARY OF STATE AUTHORIZES ADDITIONAL TIME. AND TO EXTEND THE TIME THE SECRETARY MUST DETERMINE THAT IT WOULD BE IN THE NATIONAL INTEREST TO DO SO.

THE NUCLEAR REGULATORY COMMISSION IS REQUIRED TO ACT ON LICENSES IN A TIMELY FASHION "UPON A DETERMINATION THAT ALL APPLICABLE STATUTORY REQUIREMENTS HAVE BEEN MET." IF THE NRC HAS NOT ACTED UPON A PENDING EXPORT LICENSE WITHIN 60 DAYS AFTER RECEIVING THE ADMINISTRATION'S RECOMMENDATION, IT MUST INFORM THE APPLICANT IN WRITING OF THE REASON FOR DELAY. IF, AFTER AN ADDITIONAL 60 DAYS, THE COMMISSION HAS NOT ACTED UPON THE APPLICATION, THE PRESIDENT HIMSELF MAY AUTHORIZE THE EXPORT.

THOSE THEN ARE SOME OF THE PRINCIPAL FEATURES OF THE NEW EXPORT LAW. IT IS CLEAR THAT SOME ASPECTS WILL REQUIRE CAREFUL IMPLEMENTATION IF WE ARE TO ACHIEVE ONE OF ITS FUNDAMENTAL OBJECTIVES -- RECOGNITION OF THE UNITED STATES AS A RELIABLE NUCLEAR SUPPLIER. FOR THE UNITED STATES TO CONTINUE TO EXERCISE POSITIVE INFLUENCE IN ITS EFFORT TO REDUCE THE DANGERS OF PROLIFERATION, IT MUST BE ABLE TO

ENGAGE IN NUCLEAR COMMERCE -- AND OTHERS MUST BE WILLING TO TRADE WITH US. OTHERWISE, THE NONPROLIFERATION CONSTRAINTS EMBODIED IN THE NEW ACT WILL BE OF LITTLE MEANING.

THE ACT CALLS FOR SAFEGUARDS AND CONTROLS NOT PREVIOUSLY REQUIRED IN CONNECTION WITH U.S. EXPORTS. BUT THESE SHOULD NOT BE TAKEN TO MEAN THAT THE UNITED STATES HAS ANY LESS CONFIDENCE IN THE RELIABILITY OF ITS ALLIES AND TRADING PARTNERS. NOR ARE WE LESS COMMITTED TO ASSIST OTHER NATIONS IN THE DEVELOPMENT OF SAFE NUCLEAR POWER TO MEET LEGITIMATE ENERGY NEEDS. RATHER, AS I HAVE TRIED TO INDICATE, THE NEW LEGISLATION SIMPLY REFLECTS THE GROWING PERCEPTION THAT WE MUST PAY A CERTAIN PRICE IN INCREASED SAFEGUARDS AGAINST THE RISKS OF PROLIFERATION IF WE ARE TO REALIZE THE BENEFITS THAT WILL FLOW FROM THE INCREASED USE OF NUCLEAR ENERGY. SHORT TERM ADJUSTMENTS WILL BE REQUIRED IN OUR TRADING RELATIONSHIPS. BUT, WE BELIEVE THESE ADJUSTMENTS ARE NOT SO PROFOUND AS TO BE BEYOND THE REACH OF SERIOUS NEGOTIATIONS BETWEEN FRIENDS WHOSE OBJECTIVES ARE SUBSTANTIALLY SIMILAR.

FOR EXAMPLE, IN NEW OR AMENDED AGREEMENTS FOR COOPERATION, WE ARE REQUIRED TO OBTAIN U.S. APPROVAL RIGHTS OVER THE

REPROCESSING OF NON-U.S. ORIGIN FUEL IRRADIATED IN U.S.-SUPPLIED REACTORS. WE WILL ALSO BE SEEKING TO ACHIEVE THESE RIGHTS IN EXISTING AGREEMENTS THROUGH A PROGRAM OF RENEGOTIATION, AS REQUIRED BY THE NEW LAW. BUT, IN DOING SO, WE WILL CONTINUE TO BE MINDFUL, AS I SAID EARLIER, OF THE ENERGY NEEDS OF NATIONS WHO ARE FORCED TO IMPORT FAR MORE OF THEIR ENERGY RESOURCES EVEN THAN WE. THOSE TWO NEEDS -- ENERGY SOURCES AND MINIMUM PROLIFERATION RISK -- MAKE IT ALL THE MORE IMPORTANT THAT WE WORK TOGETHER TOWARDS REACHING AGREEMENT ON MORE PROLIFERATION-RESISTANT ~~FUTURE~~ FUEL CYCLES FOR THE FUTURE.

ANOTHER PROVISION WHICH MAY BE CONTROVERSIAL IS THE FULL-SCOPE SAFEGUARDS EXPORT CRITERION THAT COMES INTO EFFECT AFTER EIGHTEEN MONTHS. SOME MAY ARGUE THAT AN AGREEMENT OF THIS KIND WOULD BE EQUIVALENT TO ADHERENCE TO THE NONPROLIFERATION TREATY. THIS MAY RAISE QUESTIONS FOR THOSE FEW NATIONS WHO, FOR VARYING REASONS, HAVE CHOSEN NOT TO ADHERE. BUT, AGAIN, THE LONG-TERM NONPROLIFERATION BENEFITS TO BE ACHIEVED WILL, I WOULD ARGUE, OUTWEIGH THE SHORT-TERM COSTS WHICH SOME MAY PERCEIVE IN THE INEVITABLE ADJUSTMENTS RESULTING FROM ACCEPTANCE OF SUCH A SAFEGUARDS REGIME.

AS I MENTIONED EARLIER, THE COMMISSION MUST MAKE A DETERMINATION IN EACH EXPORT LICENSE CASE THAT THE ISSUANCE OF THE LICENSE WILL NOT BE INIMICAL TO THE COMMON DEFENSE AND SECURITY OF THE UNITED STATES. A KEY FACTOR IN REACHING THIS CONCLUSION IS THE ASSESSMENT OF THE ADEQUACY OF SAFEGUARDS. CLEARLY THE COMMISSION IN REACHING ITS JUDGMENT IN THIS REGARD MUST DEPEND HEAVILY UPON THE ADVICE PROVIDED TO IT BY OTHER AGENCIES OF THE GOVERNMENT. MOREOVER, IT MUST RELY HEAVILY ~~ALSO~~ UPON THE WORK OF THE INTERNATIONAL ATOMIC ENERGY AGENCY IN ITS IMPLEMENTATION OF SAFEGUARDS PROGRAMS. IT IS IMPORTANT TO US ALL THAT EFFORTS BE MADE TO STRENGTHEN IN EVERY WAY POSSIBLE THE ABILITY OF THE IAEA TO FULLY DISCHARGE ITS VITAL SAFEGUARDS INSPECTION RESPONSIBILITIES. AND IN IMPLEMENTING THE NEW LAW, WE WILL BE MINDFUL OF THAT NEED AND THE NEED TO ASSIST THE AGENCY IN ITS EFFORTS TO STRENGTHEN SAFEGUARDS REGIMES.

I KNOW TOO THAT MANY OF YOU HAVE HEARD THAT THE NEW LAW IS SO COMPLEX AS TO CREATE A PROCEDURAL MORASS INTO WHICH LICENSES WILL DISAPPEAR AND FROM WHICH THEY CAN HARDLY BE EXPECTED EVER TO EMERGE. I DO NOT WANT TO MINIMIZE THE COMPLEXITY OF THE LAW. BUT NEITHER DO I BELIEVE THAT IT IS SO COMPLEX AS TO BE UNWORKABLE OR EVEN SO DIFFICULT AS TO POSE A SERIOUS IMPEDIMENT IN THE LICENSING PROCESS.

IT DOES SET FORTH SOME COMPLICATED PROCEDURES WHICH INVOLVE THE PRESIDENT'S RIGHT TO REVERSE DECISIONS OF THE NUCLEAR REGULATORY COMMISSION AND CONGRESSIONAL REVIEWS OF THOSE DECISIONS. BUT AS I SUGGESTED EARLIER SUCH CASES ARE LIKELY TO BE VERY RARE INDEED. THEY SURELY WILL NOT BE THE RULE. NOR SHOULD WE FORGET THAT TIME LIMITS HAVE BEEN SET FOR ACTION BY OUR BUREAUCRACIES. AND THOSE EXPERIENCED IN THE WAYS OF BUREAUCRACIES WILL KNOW THAT IS SURE TO HELP THE PROCESS.

I AM CONFIDENT THAT WE CAN FIND THE WAY TO MAKE THE PROCESS WORK AND WORK WELL. WE MUST. FOR ONLY THEN, CAN WE ASSURE A REGULARIZED AND PREDICTABLE PROCESS SO NECESSARY TO EFFECTIVE COMMERCE IN ANY FIELD, INCLUDING NUCLEAR.

I AM NOT HERE TO DOWNPLAY THE PROBLEMS WE FACE. THESE NEXT TWO YEARS WILL UNDOUBTEDLY BE A DIFFICULT TRANSITION PERIOD, AS WE SET ABOUT IMPLEMENTING THE NEW LAW AND GRAPPLING WITH THE HIGHLY COMPLEX TECHNICAL AND ECONOMIC PROBLEMS IN THE CONTEXT OF THE INTERNATIONAL NUCLEAR FUEL CYCLE EVALUATION. BUT, I WOULD ASSERT, WE HAVE COME A LONG WAY SINCE THIS TIME LAST YEAR IN ACHIEVING A GREATER COMMON APPRECIATION OF THE PROBLEMS AND PROSPECTS BEFORE US.

OUR OBJECTIVE -- YOURS AND OURS -- MUST BE TO REACH A CONSENSUS ON AN EFFECTIVE INTERNATIONAL NUCLEAR ECONOMY WHICH RECOGNIZES AND DEALS REALISTICALLY WITH THE RISKS OF NUCLEAR PROLIFERATION. BUT THIS CONSENSUS MUST REFLECT THE REALITY THAT MANY, IF NOT MOST, NATIONS DEPEND TO A GREATER EXTENT THAN THE UNITED STATES ON FUEL IMPORTS TO MEET THEIR ENERGY NEEDS. FOR THEM, IT IS ABSOLUTELY ESSENTIAL TO HAVE AN UNINTERRUPTED SOURCE OF SUPPLY.

IT IS VERY MUCH IN OUR MUTUAL INTEREST FOR THE UNITED STATES TO CONTINUE ITS TRADITIONAL ROLE AS A RELIABLE SUPPLIER. IF WE DO NOT, WE WILL ALL BE LOSERS. FOR I BELIEVE, AND I KNOW THIS AUDIENCE AGREES, THAT NUCLEAR POWER IS A RELIABLE AND VITAL COMPONENT IN THE WORLD'S FUTURE ENERGY MIX. SO LET US STRIVE TOGETHER TO REACH THIS CONSENSUS.

セッション 1

D.ジョージ 本論文

発表は 3 月 14 日 ~~午前 時~~ 午後 2 時10分
以降に願います。

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Final

Chairman's Speech to the 11th Annual Conference of the Japan Atomic Industrial Forum to be held in Tokyo from 14-16 March 1978

Gentlemen,

You will be aware that Australia has large deposits of commercially recoverable uranium. You may also be aware that Australia has no current plans to introduce nuclear power because of the availability of alternative sources of energy. Without the pressing need to supply a domestic market Australia has been able to give long and careful thought to the development of its uranium industry. This culminated in the Australian Government's decision to allow the development of the Ranger deposits subject to stringent conditions, some of which I will refer to later. This decision was taken with a high sense of moral responsibility both towards Australia and Australians, and to the international community of nations.

Australia announced its uranium policy in August last year. It was very well documented, and I presume you will all have had the opportunity to read the papers made available by the Government which explained the decisions and the reasons for them.

Since then Australia held an election in December and the Government was returned to office: the policies remain unchanged. The decision taken by Australia flowed from four fundamental considerations -

- the need to reduce the risk of nuclear proliferation;
- the need to supply essential sources of energy to an energy-deficient world;
- the need to protect effectively the environment in which mining development will take place;
- the need to ensure that proper provision is made for the welfare and interests of the Aboriginal poeple in the Alligator Rivers Region and of all other people living in the Region and working on the development projects.

The first two considerations are related to international affairs and the last two to domestic matters. Today I would like to discuss the first two considerations and to indicate to you the progress in implementation of the Government's policy.

In his statement announcing the decision on 25 August 1977 the Prime Minister said that the export of Australian uranium will decrease the risks of further proliferation of nuclear weapons and will support and strengthen the NPT.

Australia's safeguards policy was announced in May 1977 and was the result of an exhaustive interdepartmental study which, inter alia, took account of the concern expressed in the First Report of the Ranger Uranium Environmental Inquiry. This safeguards policy ensures that the uranium we supply to others will be for peaceful purposes only and will not be misused, and that our unqualified commitment to the non-proliferation of nuclear weapons is put into effect.

It may seem at times that Australia, Canada and the United States are acting in concert on the safeguards issue. This should not be misunderstood. There is no intention or desire on our part to form a cartel for the supply of uranium. We want no part of a uranium OPEC. But we do believe there should be as much uniformity as possible in the conditions which suppliers attach to their product.

Australia's commitment to non-proliferation is also demonstrated by our participation in the International Nuclear Fuel Cycle Evaluation.

We are very pleased with the way in which the INFCE Working Groups have settled down to their task. It seems to us there is a good deal of common concern and a genuine desire to thoroughly explore the technology from the point of view of non-proliferation. Australia is participating in a number of the Working Groups and is a co-chairman of one of them. As I announced at the IAEA Board of Governors meeting two weeks ago, Australia will make a direct financial contribution to the IAEA so that it may service the work of INFCE.

While INFCE is an important international forum for the exchange of ideas and for the forging of common objectives, equally important as far as Australia is concerned are bilateral discussions.

As I mentioned earlier, Australia does not wish to be part of a suppliers' cartel; its bilateral discussions will be with both consumers and suppliers. As you will know, we have put before a number of nations a model bilateral safeguards agreement. This forms a catalyst for what we hope will be fruitful discussion, and we place as much emphasis on our bilateral discussions as we do on the multi-national exchanges occurring in INFCE. Mr Justice Fox has been appointed Ambassador at Large, and has been particularly active in exchanging views with our potential customers and existing supply nations. Mr Justice Fox has taken a number of personal initiatives in the safeguards area as well as advising the Government.

The worldwide demand for energy will continue to increase. Non-renewable, easily accessible sources of energy, particularly oil, are decreasing at such a rapid rate that demand will probably outstrip supply before the end of the next decade. Developed nations, particularly those with little or no indigenous source of energy look to nuclear power as the only alternative capable of providing large blocks of energy.

Australia, as a country comparatively well endowed with certain resources, has an obligation to the rest of the world to share these resources; particularly coal and uranium. For uranium Australia has a further obligation, a refusal to supply could be regarded as inconsistent with Article IV of the NPT. Such a refusal would run counter to Australian policy, which is to give every possible support to the NPT.

The INFCE study concerns itself in part with the supply of resources and we are pleased that Australia is a co-chairman of INFCE Working Group 3 - Assurances of Long Term Supply of Technology, Fuel and Heavy Water and Services in the Interest of National Needs Consistent with Non-Proliferation. Australia recognises the desire of some consumer countries for assurance on the future supply of nuclear fuel. It has no desire to withhold supply where non-proliferation concerns are satisfied.

The problem with effective non-proliferation measures is that they can add to costs involved, reduction in sovereignty, and create uncertainties about long-term demand and supply. Nevertheless, these measures affect all countries, supplier and supplied alike, and as such should be embraced by NW and NNW States. The natural reaction of any State is to wish to limit the application of such disabilities to itself; but as we see it, all countries have an overriding interest in arriving at mutually acceptable solutions to the proliferation problem. It is not a matter of a country or countries subjecting itself or themselves to non-proliferation burdens for the benefit of others. Proliferation is a problem for all.

The procedures by which sales of Australian uranium will be made have yet to be announced. The Ranger Inquiry recommended the establishment of a Uranium Marketing Authority. The Government accepted this in principle, and detailed planning to establish the terms of reference of this body is still in progress. It is intended that the Authority should ensure that the Government has the proper knowledge, oversight and control of the commercial arrangements under which Australian uranium is exported. It has already been decided that all commercial contracts in the future will include a clause noting that the transaction is subject to the bilateral agreement between Australia and the recipient country. Other details of the form of contract are still being evolved. The Government, in announcing its policy, attached the greatest importance to the orderly development of Australian uranium resources. It stressed the need for the industry to develop as a stable and secure long-term supplier if energy to other countries is to be provided on fair and reasonable terms, and not be subject to volatile events in overseas markets. There are likely to be substantial economic benefits from uranium mining, and the Government noted its intention to examine, with the industry, a possible framework of taxation which would ensure the accrual of an appropriate share of the uranium profits in the public sector.

The Government sees commercial negotiations and safeguards operations as proceeding in parallel. At this moment we stand ready to progress a Japan/Australia Agreement.

The stage is therefore set for new Australian deposits to be developed. However, there are still organisational decisions to be made, subsidiary legislation to be passed, and regulations to be formulated before work can begin at the mine sites. This legislation is currently being prepared and will be brought before Parliament in the near future.

Industry must also meet its obligations with respect to environmental acceptability and complete negotiations on a settlement with the local aboriginal people. These matters require time, and progress has been made in the six months since the Government's decision was announced. The Ranger Uranium Environmental Inquiry has recommended that the new deposits be developed sequentially. The Government has stated that various requirements and procedures which must be carried out will in fact lead to development being of a sequential nature. I have already stated that the Government is fully aware of the need to supply the rest of the world with uranium. Australia will do its utmost to ensure that the obligation is met and we are moving ahead with development as quickly as possible within the context of our overall policies.

On the subject of overseas investment in Australian uranium ventures, the Government's position was stated in early 1976. In brief, the Government places no restrictions on overseas investment in prospecting and exploration, but it insists that mines commencing production will be at least 75% Australian owned and controlled. Certain portfolio overseas shareholdings may be excluded in calculating the extent of overseas ownership.

The uranium debate has involved all sections of the Australian community. One group which has shown a particular interest is the trade unions, not only because their members will be directly involved in the industry but because of their concern with environmental, ecological, and moral issues.

The Executive of Australian Council of Trade Unions has considered two main questions; one is the existing commitment to supply uranium, the other is the future mining of uranium. On 16 February 1978 the Executive recommended to a special conference of affiliated unions that - "We believe there is no reasonable alternative to honouring commitments under existing contracts entered into prior to December 1977 . . . " and again " . . . recognising these dangers we do not however believe that there should be a total renunciation of intention to supply from new mines. In this respect we accept the statement from the conclusions of the First Fox Report . . . "

The ACTU still needs to be satisfied as to the adequacy of safeguards and some other matters before it would agree to the opening of new mines, and it has called for consultation on these matters. The Government has stated it would be glad to consult with the ACTU on these issues and I would hope that these processes will begin shortly.

The foregoing has concerned the development of the uranium mining industry in Australia, and it remains to consider Australian policy towards other parts of the fuel cycle. Lacking a nuclear power program, we have no interest today in becoming involved domestically in anything but the front end of the cycle; indeed the Government has specifically stated that Australia has no intention of disposing of other countries' wastes. However, our interest in seeing our raw products upgraded has meant a continuing interest in Australian uranium being eventually exported as enriched UF_6, and not as yellowcake. We have, over the past decade, participated in various international studies of enrichment, and currently are involved in a bilateral study with Japan. We expect such discussions may be held also with other countries. We have made substantial progress in our own research studies of centrifuge enrichment. At this time, beyond a desire to see the maximum national benefit being derived from our uranium resources, we have made no decisions on the establishment of conversion or enrichment facilities within Australia, but will continue actively to study the situation.

I consider multinational facilities to be an interesting concept which seems to offer some advantages in control and non-proliferation reassurance. I look forward to the deliberations by INFCE in this area, and also in the area of supply assurance.

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3/14

[illegible] UNTIL
p.m. 3:00

Final

NUCLEAR POWER DEVELOPMENT IN IRAN AND THE CONCEPT OF INTERNATIONAL COOPERATION

PRESENTED BY:
AKBAR ETEMAD

11TH ANNUAL CONFERENCE OF THE
JAPAN ATOMIC INDUSTRIAL FORUM

TOKYO, 14-16 MARCH, 1978.

③ 3/29 発注 4/6 納期

Nearly two decades ago, Iran undertook a major economic and social transformation effort to substantially improve the quality of life of Iranians with a significant speed. The development achievements of Iran are already visible in her evolving economic and social structures. The process of socio-economic and technological development, however, generates an ever-increasing need for various resources and services. One such fundamental resource is energy. Although Iran is a major supplier of oil, she has, nevertheless, decided to utilize nuclear energy on a large scale. The reasons are clear and simple:

First: The known oil reserves of Iran are rapidly depleting, and she has to search for alternative sources of energy. Basically, the world as a whole is faced with this necessity of choice,

Second: We all need to rationalize the use of hydrocarbons which has significant and numerable industrial applications,

<u>THIRD</u>: IT IS CLEAR NOW THAT OUR WORLD-WIDE EFFORTS FOR THE DEVELOPMENT OF LONG-TERM ENERGY ALTERNATIVES WILL REQUIRE A SUBSTANTIAL PERIOD OF TIME TO BEAR THE EXPECTED RESULTS. IT IS EQUALLY CLEAR THAT NUCLEAR ENERGY IS OUR ONLY VIABLE OPTION FOR TRANSITION FROM THE FOSSIL FUEL ENERGY ECONOMY OF THE PRESENT, TO THE FUTURE ERA OF ABUNDENT AND RENEWABLE SOURCES OF ENERGY.

<u>FOURTH</u>: NUCLEAR ENERGY IS HIGHLY CAPITAL-INTENSIVE, AND IRAN IS PRESENTLY IN A FAVORABLE POSITION TO PROVIDE FOR THE CAPITAL-FORMATION REQUIREMENTS OF NUCLEAR ENERGY.

<u>FIFTH</u>: LONG-TERM INDICATIONS ARE THAT THE FINANCIAL COSTS OF GENERATING ENERGY BY THE USE OF CONVENTIONAL FUELS WILL UNAVOIDABLY CONTINUE TO INCREASE. THEREFORE, WITH THE OTHER ADVANTAGES IN MIND, THE NUCLEAR OPTION WILL INCREASINGLY BECOME MORE ATTRACTIVE FROM AN ECONOMICAL POINT OF VIEW.

THE LONG-TERM ENERGY POLICIES OF IRAN ARE BASED ON THESE FUNDAMENTAL CONSIDERATIONS. BRIEFLY STATED, THEY ARE AS FOLLOWS:

(1) Preservation of Iran's energy independence in the future,

(2) Progressive substitution of oil through energy diversification, with special emphasis on the utilization of natural gas,

(3) Rapid and sizable use of nuclear energy,

(4) Active research for long-term alternative sources of energy with particular emphasis on renewable sources.

According to the existing plans, Iran intends to install 23,000 MW of nuclear power by 1994. Four power plants with the total capacity of 4200 MW are under construction. The first power plant will be connected to the national grid in 1981. The other three will become operational by 1984. In addition, four units of 1200 MW each are under contract with the completion of the last unit scheduled for 1988.

For fuel supply, we have undertaken several parallel activities. We have undertaken a very ambitious uranium exploration program. Over 500,000 square kilometers is under active airborne survey for radiometry and gravimetry. Parallel with this, an extensive ground survey is being conducted.

A GREAT NUMBER OF VERY INTERESTING ANOMALIES HAVE BEEN LOACTED. GIVEN VARIOUS INDICATIONS, WE ARE REASONABLY OPTIMISTIC REGARDING THE POSSIBILITY OF FINDING SIZABLE RESERVES OF URANIUM IN IRAN. WE HAVE ALSO CONCLUDED SOME AGREEMENTS FOR JOINT URANIUM EXPLORATION IN THIRD COUNTRIES.

AS FOR URANIUM ENRICHMENT, IRAN HAS DIRECTED ITS EFFORTS TOWARDS PARTICIPATION IN MULTI-NATIONAL ENRICHMENT FACILITIES TO PROVIDE FOR ITS ENRICHMENT NEEDS.

THE RELATED ACTIVITIES FOR THE IMPLEMENTATION OF IRAN'S NUCLEAR ENERGY PROGRAM INCLUDE RESEARCH AND DEVELOPMENT WORK, SAFETY ASSESSMENT, RADIATION PROTECTION, ENVIRONMENTAL RESEARCH, MANPOWER MOBILIZATION, WASTE MANAGEMENT, AND PUBLIC AWARENESS. I SHALL NOT ELABORATE ON THESE ACTIVITIES, AS I PREFER TO ADDRESS MYSELF TO SOME GLOBAL ISSUES AT THE INTERNATIONAL LEVEL.

STRAINTS

TODAY, A CONSIDERABLE PART OF THE WORLD COMMUNITY, WHICH INCLUDES THE WESTERN AND EASTERN COUNTRIES AS WELL AS THE DEVELOPED AND DEVELOPING NATIONS, MANIFEST A STRONG DETERMINATION TO USE NUCLEAR ENERGY ON A GROWING SCALE. HOWEVER, THE CHALLENGE OF NUCLEAR TECHNOLOGY FOR THE WORLD AS A WHOLE, AND THE DEVELOPING NATIONS IN PARTICULAR, HAS NOT BEEN DEVOID OF VARIOUS CONSTRAINTS AND COMPLEXITIES. HERE, I SHALL ONLY REFER TO SOME OF THE PERTINENT ISSUES, AND WILL THEN PROCEED TO ELABORATE ON THEIR IMPLICATIONS ON THE NOTION OF INTERNATIONAL COOPERATION FOR THE WORLDWIDE UTILIZATION OF NUCLEAR ENERGY.

AN IMMEDIATE AND CONTINUING ISSUE FOR THE SUPPLIER AND THE RECIPIENT NATIONS BOTH, IS THE TRANSFER OF TECHNOLOGY. A LARGE-SCALE AND WORLDWIDE DIFFUSION OF NUCLEAR TECHNOLOGY INVOLVES HIGHLY COMPLEX AND DIVERSIFIED TECHNICAL AND INDUSTRIAL RELATIONS WITH STRONG POLITICAL, ECONOMIC AND MANAGERIAL ATTRIBUTES. RELATED TO THE PROCESS OF TECHNOLOGY TRANSFER IS THE RISK OF NUCLEAR PROLIFERATION. IT WOULD, HOWEVER, BE ILLUSIONARY TO BELIEVE THAT WE CAN ELIMINATE

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THE RISKS OF PROLIFERATION THROUGH TECHNOLOGICAL DENIAL. THE CONTEMPORARY WORLD COMMUNITY IS HIGHLY INTERDEPENDENT; ITS MEMBERS ARE DEEPLY CONSCIOUS OF THEIR NEED FOR TECHNOLOGICAL SELF-SUFFICIENCY; AND TECHNOLOGICAL EVOLUTION, BOTH HORIZONTAL AND VERTICAL, IS ALMOST IMPOSSIBLE TO CONTAIN IN THE LONG-RUN. WE MUST REMEMBER THAT TECHNOLOGY HAS ALWAYS POSED CERTAIN DANGERS TO OUR COMMUNITIES AND THEIR INSTITUTIONS. BUT OUR COLLECTIVE WISDOM HAS, BY AND LARGE, PREVAILED. OUR NEED FOR A COLLECTIVE WISDOM TO COPE WITH THE CHALLENGE OF NUCLEAR TECHNOLOGY DIFFUSION IS NOW CLEARLY VISIBLE.

ANOTHER PRINCIPAL ISSUE IS FUEL SUPPLY, INCLUDING BOTH THE RAW MATERIALS AND THE PROVISION OF RELATED TECHNOLOGIES AND SERVICES. WE ARE AWARE THAT THE KNOWN URANIUM RESERVES OF THE WORLD HAVE A LIMITED GEOGRAPHICAL DISTRIBUTION. WE ALSO KNOW THAT THE INTERNATIONAL TRADE OF THIS IMPORTANT ELEMENT IS AFFECTED BY COMPLEX POLITICAL FACTORS, WITH STRONG ECONOMIC IMPLICATIONS WHICH UNDERMINE THE LONG-TERM CREDIBILITY OF URANIUM SUPPLY TO A SIGNIFICANT EXTENT.

IT IS PRECISELY SUCH CONSTRAINING FACTORS WHICH HAVE GIVEN RISE TO THE GROWING CONCERNS OVER THE "CARTELIZATION OF SUPPLY". THE CONDITIONS ARE FURTHER CONSTRAINED BY POLICIES REGARDING THE BACK-END OF THE FUEL CYCLE WHICH ARE EVOLVING WITHOUT DIALOGUE AND UNDERSTANDING AT THE GLOBAL LEVEL. THIS REALITY HAS TENDED TO CREATE APPREHENSIONS ABOUT THE "MONOPOLIZATION OF THE SENSETIVE TECHNOLOGIES". WHAT SEEMS TO DEEPEN THE CONCERNS OF THE POLITICIANS AND THE NUCLEAR ENERGY PLANNERS AROUND THE WORLD EVEN FURTHER, IS THE POSSIBLE GEOGRAPHICAL CONVERGENCE OF THE AVAILABILITY OF THE RAW MATERIALS AND THE SENSETIVE FUEL CYCLE TECHNOLOGIES. WE MUST ADMIT THAT IT IS EXCEEDINGLY DIFFICULT, IF NOT IMPOSSIBLE, TO DESIGN, DEVELOP,AND MANAGE A CREDIBLE AND LONG-TERM NUCLEAR ENERGY INFRASTRUCTURE WITH SUCH INNER FEELINGS OF INSECURITY AND APPREHENSION.

WE TRULY HOPE THAT THE INTERNATIONAL NUCLEAR FUEL CYCLE EVALUATION (INFCE) WHICH HAS AMONG OTHER THINGS, ADDRESSED ITSELF TO THE FUNDAMENTAL ISSUES OF NUCLEAR FUEL SUPPLY, PROVIDES US WITH THE COLLECTIVE SOLUTIONS WHICH ARE SO DESPERATELY NEEDED.

Nuclear energy is clearly the most capital-intensive energy technology that we have brought to commercial use. It also has a long lead-time. These attributes create formidable financial burdens for those nations which do not have a credible industrialized economy or abundent foreign exchange-earning resources. They, however, need to use nuclear energy at an increasing rate. Regretably, we have not even begun to evaluate the implications of this gap for the future economy of the world. As yet, the appropriate international sources and mechanisms of financing are inadequate.

Furthermore, nuclear energy has been subject to increasing public controversy in recent years. The public debates are dominated by such issues as the safety of nuclear installations, waste management, safeguards, physical security, plutonium use, and, among certain circles, the need for nuclear energy altogether. We all know that the consciousness we have shown for, and the effort we have devoted to the safety of nuclear energy is nearly unparalleled. This, however, has hardly been understood by the public, nor has the public been adequately informed about the realities of nuclear power and its immense peaceful potentials. Therefore, the public does

NOT HAVE THE APPROPRIATE INFORMATION THAT A CREDIBLE JUDGEMENT NEEDS. IN INFORMING THE PUBLIC, WE SHOULD BE AWARE OF SOME IMPORTANT CONSIDERATIONS.

IT IS IMPORTANT TO NOTE THAT THE PUBLIC DEBATE ON NUCLEAR ENERGY IN THE MORE AFFLUENT SOCIETIES IS, AT LEAST TO SOME EXTENT, A REFLECTION OF A WIDER SOCIAL ATTITUED, NAMELY THE GROWING RESERVATION AGAINST THE EXCESSIVE USE OF SCIENCE AND TECHNOLOGY. THE PUBLIC SHOULD REALIZE THAT ITS DAILY LIFE HABITS ARE THE VERY PRODUCT OF TECHNOLOGY; IT SHOULD ALSO UNDERSTAND THAT ANY TECHNOLOGY POSES CERTAIN CONSTRAINTS; AND THAT WE CANNOT ASPIRE TO BETTER STANDARDS AND QUALITY OF LIFE WITHOUT ACCEPTING THESE CONSTRAINTS. ALTHOUGH TECHNOLOGICAL INNOVATIONS AND IMPROVEMENTS ARE ALWAYS FEASIBLE, THE REALITY OF THE RELATIVE VIRTUE OF TECHNOLOGY OUGHT TO BE COMPREHENDED; IN OTHER WORDS, "WE CANNOT HAVE OUR CAKE AND EAT IT".

WE SHOULD ALSO HELP THE PUBLIC TO DEVELOP A COMPARATIVE UNDERSTANDING OF ALTERNATIVE ENERGY TECHNOLOGIES AND THEIR RELATIVE MERITS FOR VARIOUS MODES AND STANDARDS OF LIFE THAT WE MAY ASPIRE TO. FOR EXAMPLE, THE PUBLIC SHOULD REALIZE THAT THE INHERENT CONSTRAINTS OF CONVENTIONAL ENERGY TECHNOLOGIES

MAKE IT IMPOSSIBLE FOR US TO SUSTAIN AN AFFLUENT WAY OF LIFE FOR A LONG TIME, OR BEYOND THE TWENTIETH CENTURY.

LASTLY, IN RELATING TO THE PUBLIC OPINION, WE SHOULD AVOID TAKING A DEFENSIVE STANCE; THIS ATTITUDE WILL CERTAINLY GENERATE GREATER DOUBTS IN THE MINDS OF PEOPLE. NOR SHOULD WE ASSUME THAT TECHNICAL DIALOGUE ALONE CAN BRIDGE THE GAP BETWEEN US AND THE PUBLIC. WE SHOULD ALSO NOT BE TEMPTED TO TAKE A HASTY, INCOHERENT, AND ISOLATED APPROACH TOWARDS THE PUBLIC IN OUR RESPECTIVE COUNTRIES. WE URGENTLY NEED A COMMON APPROACH AND LANGUAGE, OBVIOUSLY TAKING INTO ACCOUNT THE PECULIARITIES OF EACH COUNTRY. OTHERWISE, WE MIGHT VERY WELL DISTORT OR POISON THE PUBLIC OPINION EVEN FURTHER. WE OUGHT TO REALIZE THAT WE ARE SPEAKING TO A "WORLD PUBLIC OPINION"; A RATHER ORGANIZED AND VISIBLY INTERDEPENDENT BODY OF THINKING, BORNE THROUGH THE IMMENSE COMMUNICATION INFRASTRUCTURE OF THE CONTEMPORARY WORLD.

PERHAPS THE LEAST ACKNOWLEDGED CONSTRAINT FOR THE NATIONAL DEVELOPMENT AND UTILIZATION OF NUCLEAR ENERGY IS THAT OF MANAGEMENT. NUCLEAR ENERGY ITSELF, INVOLVES NUMEROUS

TECHNOLOGIES WHICH ARE INHERENTLY COMPLEX AND RAISE CUMBERSOME MANAGEMENT PROBLEMS, PARTICULARLY FOR THOSE NATIONS WHICH HAVE NOT YET CROSSED THE TECHNOLOGICAL THRESHOLD. FURTHERMORE, ALMOST EVERY ASPECT OF NUCLEAR TECHNOLOGY IS OF A LONG-TERM NATURE, BE IT POWER PLANT CONSTRUCTION, PROVISION OF FUEL, FINANCING, SAFETY ASSESSMENT, WASTE MANAGEMENT, PUBLIC ACCEPTANCE, OR OTHERWISE. THIS CHARACTERISTIC ALSO IMPOSES HEAVY MANAGEMENT BURDENS.

THOSE NATIONS WHICH ARE ENGAGED IN THE DEVELOPMENT AND UTILIZATION OF NUCLEAR ENERGY, NOTABLY THE NEW-COMERS IN THIS FIELD, ARE CONFRONTED WITH YET ANOTHER MANAGEMENT BURDEN WITH FAR-REACHING FINANCIAL IMPLICATIONS. THIS CONSTRAINT BASICALY ARISES FROM THE LACK OF CREDIBLE COLLECTIVE INTERNATIONAL ARRANGEMENTS FOR OPTIMAL UTILIZATION OF NUCLEAR ENERGY. FOR EXAMPLE, THE ABSENCE OF APPROPRIATE ARRANGEMENTS FOR LONG-TERM NUCLEAR FUEL ASSURANCE, FORCES EVERY COUNTRY TO TAKE INDEPENDENT MEASURES FOR FUEL SUPPLY AND STORAGE. THIS IMPOSES CUMBERSOME PLANNING, FINANCIAL AND MANAGEMENT CONSTRAINTS ON OUR NATIONAL RESOURCES. WE ALL FEEL SIMILAR CONSTRAINTS IN RELATION TO OTHER DOMAINS SUCH AS TECHNOLOGY TRANSFER, THE FINANCING OF NUCLEAR PROGRAMS,

FUEL CYCLE SERVICES, MANPOWER MOBILIZATION, REGULATORY FUNCTIONS, PHYSICAL SECURITY, AND WASTE MANAGEMENT.

THE MANAGEMENT OF THESE ISSUES BECOMES EXCEEDINGLY EASIER IF WE COULD ARRIVE AT APPROPRIATE COOPERATIVE ARRANGEMENTS WITH A LONG-TERM CREDIBILITY. HOWEVER, OUR EXPERIENCE WITH WORLD COOPERATION IN RECENT YEARS, HAS NOT BEEN VERY ENCOURAGING; INDEED THE PREVAILING INTERNATIONAL ATTITUDES AND POLICIES HAVE TENDED TO COMPLICATE THE MANAGEMENT OF NATIONAL NUCLEAR PROGRAMS ALMOST EXPONENTIALLY. WE NEED TO REALIZE THAT THE IMPOSITION OF EVER-INCREASING CONDITIONS, BEYOND ENDANGERING EFFICIENT MANAGEMENT OR CREATING FORMIDABLE FINANCIAL BURDENS, WILL ULTIMATELY MAKE THE UTILIZATION OF NUCLEAR ENERGY ALTOGETHER IMPRACTICAL.

HOWEVER, THE MOST DOMINANT PROBLEM CONFRONTING US, AND THE WORLD COMMUNITY AS A WHOLE, IS NUCLEAR PROLIFERATION. WE HAVE EXPRESSED OUR OPINIONS AT VARIOUS OCCASIONS ON THIS SUBJECT. AS I HAVE STATED BEFORE, IT IS OUR MISSION TO TAKE THE CHALLENGE OF PROLIFERATION AND RESOLVE IT. THE NUCLEAR POLICY-MAKERS AND SCIENTISTS CANNOT BE INDIFFERENT TO THE

FATE OF PROLIFERATION; OTHERWISE, THE PROLIFERATION ISSUE WILL ALMOST SURELY ENDANGER THE INHERENT CAPABILITIES OF NUCLEAR ENERGY AND ITS FUTURE DEVELOPMENT. INACTION, HOWEVER, IS MORE DESIRABLE THAN MISCONCEIVED ACTION. PROLIFERATION IS NO ENIGMA; ITS ROOTS ARE THE INNER SENSE OF INSECURITY AMONG NATIONS. THE PSYCHOLOGICAL IMPLICATIONS OF TECHNOLOGICAL BARRIERS ONLY HIGHTEN THIS SENSE OF INSECURITY AND, AS SUCH, ARE HIGHLY PROLIFERATION PRONE.

THERE IS ANOTHER IMPORTANT ASPECT TO THE PROLIFERATION ISSUE THAT WE HAVE TENDED TO NEGLECT. WE OUGHT TO REALIZE THAT OUR PREVAILING APPROACH TO NON-PROLIFERATION HAS FAR-REACHING ECONOMIC AND FINANCIAL IMPLICATIONS THAT WE NEED TO ASSESS; IN OTHER WORDS, NON-PROLIFERATION HAS A COST AND WE SHOULD DEVELOP THE APPROPRIATE CRITERIA FOR ITS PROVISION. IT IS HARD TO SEE HOW WE CAN DEVELOP AND MAINTAIN A VIABLE INTERNATIONAL NON-PROLIFERATION ORDER WITHOUT ACCOMMODATING FOR THIS OBVIOUS REQUIREMENT.

THE FUNDAMENTAL ISSUES I HAVE TOUCHED UPON HERE ARE AMONG THE KEY EXISTING PROBLEMS CONFRONTING US TODAY. THEY DEPICT A RATHER DISILLUSIONING OUTLOOK FOR THE FUTURE OF NUCLEAR ENERGY.

AS I STATED EARLIER, THE DEVELOPMENT OF A SOUND NUCLEAR ENERGY INFRASTRUCTURE IS A VERY COMPLEX UNDERTAKING FOR MOST NATIONS. THE ENERGY TECHNOLOGIES OF THE FUTURE WILL BE EVEN MORE COMPLEX. ACCORDINGLY, THE INDEPENDENT DEVELOPMENT OF THESE TECHNOLOGIES WILL BECOME INCREASINGLY MORE DIFFICULT AS THEIR CHALLENGE GOES BEYOND THE CAPABILITIES OF A SINGLE NATION.

SECONDLY, THE USE OF NUCLEAR ENERGY AT A GLOBAL LEVEL REQUIRES INTRICATE INTERDEPENDENCIES WITH FAR-REACHING POLITICAL, PSYCHO-SOCIAL, AND ECONOMIC AND FINANCIAL IMPLICATIONS THAT WE SHOULD RESPOND TO. I SHALL REFER TO SOME EXAMPLES. WHETHER WE TAKE THE CONVENTIONAL FOSSIL-BASED ENERGY TECHNOLOGIES OR NUCLEAR ENERGY, WE ARE CONFRONTED WITH A LIMITED, BOTH QUANTITATIVE AND GEOGRAPHICAL, AVAILABILITY OF THEIR RAW MATERIALS. THE OIL PRICE ADJUSTMENTS IN RECENT YEARS, WHICH IN THEMSELVES DID NOT REPRESENT A CRUCIAL CHANGE IN THE PATTERN OF ENERGY

UTILIZATION, HAS CLEARLY DEMONSTRATED OUR INTERDEPENDENCE; THE EVOLVING ECONOMICS OF URANIUM WILL CERTAINLY REINFORCE THIS INTERDEPENDENCY EVEN FURTHER.

OWING TO OUR COMMUNICATION CAPABILITIES, THE PSYCHO-SOCIAL FACETS OF INTERDEPENDENCE ALSO, ARE BECOMING MORE VISIBLE. FOR INSTANCE, WE CANNOT DEFINE OUR PERCEPTIONS OF NUCLEAR SAFETY TOTALY INDEPENDENT OF ONE ANOTHER AND OUTSIDE THE LARGER CONTEXT OF THE WORLD COMMUNITY; THERE IS A "WORLD PUBLIC OPINION" IN THIS RESPECT THAT CANNOT BE IGNORED.

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IN ADDITION TO THESE INHERENT REQUIREMENTS, WHICH ESSENTIALLY STEM FROM THE COMPLEXITY OF NUCLEAR ENERGY AND THE INTERDEPENDENCIES THAT IT IMPOSES, ARE SOME FUNDAMENTAL ISSUES WHICH WE ARE RESPONSIBLE FOR, AS THEY ARE PRODUCTS OF OUR PERCEPTIONS AND ATTITUDES. I REFERRED TO A NUMBER OF THESE ISSUES EARLIER IN MY STATEMENT.

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ERATION

HOW SHOULD WE RESPOND TO THESE PROBLEMS? ISOLATED APPROACH WILL CERTAINLY NOT SUFFICE; IN CERTAIN DOMAINS SUCH AS NON-PROLIFERATION, THEY ARE INDEED BOUND TO HAVE ADVERSE

EFFECTS. I TEND TO BELIEVE THAT THE CONVENTIONAL NOTIONS OF INTERNATIONAL COOPERATION WILL NOT BE FUNCTIONAL. WE NEED A NEW CONCEPT OF GLOBAL COOPERATION WHICH WOULD TRANSCEND THE EXISTING CONCEPTIONS.

IT IS INDEED DIFFICULT TO DEVELOP A NEW FRAMEWORK FOR NUCLEAR COOPERATION READILY. HOWEVER, WE CAN PRESENT SOME CRITERIA UPON WHICH A NEW CONCEPT OF WORLD COOPERATION SHOULD BE INSTITUTED. HERE ARE A FEW SUGGESTIONS:

FIRST: WE SHOULD CONCEIVE A COOPERATION ARRANGEMENT THAT IS ALIEN TO THE TRADITIONAL TENDENCIES FOR DOMINATION.

SECOND: WE NEED TO DEVELOP A DEEPER SENSE OF MUTUAL TRUST AMONGST OURSELVES. THE PREVAILING SENSE OF DISTRUST IN THE WORLD COMMUNITY IS SELF-DEFEATING. THE "DENIAL APPROACH" TO PROLIFERATION IS IN FACT A CLEAR REFLECTION OF THIS DISTRUST.

THIRD: WE NEED TO REALIZE THAT A MEANINGFUL COOPERATION IN NUCLEAR ENERGY CANNOT BE BASED ON A PURELY MERCANTILISTIC APPROACH; WE NEED TO SUBSTITUTE THIS TENDENCY WITH ANOTHER

APPROACH WHICH IS ESSENTIALLY ORIENTED TO THE SOLUTION OF OUR COLLECTIVE NEEDS AT THE GLOBAL LEVEL.

FOURTH: WE MUST REALIZE THAT if CREDIBLE COOPERATION IN THE NUCLEAR FIELD ~~MIGHT VERY~~ is to WELL HAVE SOME IMPLICATIONS ON OUR COMMON CONCEPTIONS OF NATIONAL SOVEREIGNTY, then we should all be prepared to accommodate them.

FIFTH: THE FUTURE COOPERATION FRAMEWORK SHOULD BE GLOBAL IN COVERAGE; IT SHOULD INCORPORATE THE NORTH AND SOUTH, AS WELL AS THE EAST AND WEST. THIS MEANS THAT COOPERATION AMONGST THE INDUSTRIALIZED NATIONS ALONE WILL NOT YIELD SATISFACTORY RESULTS; IN SOME CASES, IT MIGHT EVEN HAVE ADVERSE EFFECTS ON THE DEVELOPMENT OF NUCLEAR ENERGY.

SIXTH: ANY ARRANGEMENT FOR NUCLEAR COOPERATION SHOULD BE CAPABLE OF INTEGRATING THE TWIN FUNCTIONS OF PROMOTION AND CONTROL. THE PROCESS OF NUCLEAR TECHNOLOGY DEVELOPMENT IS A TWO-SIDED COIN AND UNLESS WE ACHIEVE AN OPTIMUM BALANCE BETWEEN THESE COMPLEMENTARY FACETS, IT IS IMPOSSIBLE TO RESOLVE THE KEY ISSUES ASSOCIATED WITH NUCLEAR ENERGY.

<u>Seventh</u>: Our policies for nuclear cooperation should have sufficient continuity to be credible in the long-run; we should avoid changing the dominant international nuclear options, if we want to foster a collective commitment to cooperation.

<u>Eighth</u>: Last but not least, is the need to remove the underlying causes of proliferation. As I tried to convey before, nuclear proliferation is a symptom. We need to resolve the proliferation issue outside the domain of nuclear energy, and in a global political context. Otherwise, nuclear cooperation will be subject to severe constraints, as it is today.

Before concluding, I wish to state that the development of a viable framework for nuclear cooperation needs time. During this transitional period, we should refrain from hasty or incoherent action which hinders or endangers this evolutionary trend. We need a good deal of dialogue and faith to go through this historical process. In this connection, I am sure that the importance of continuous dialogue on a large and international scale is felt by us

ALL. It is precisely for this reason that I wish to use this opportune moment and thank the Japan Atomic Industrial Forum for doing so much and so well in gathering us together here.

3/27
Final

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発表は 3 月14 日 ~~午前~~ 午後 6 時
以降に願います。

EMBARGO UNTIL
3/14 ~~a.m.~~ p.m. 6:00

JAPAN ATOMIC INDUSTRIAL FORUM

MARCH 1978

THE DEVELOPMENT OF FAST BREEDER REACTORS IN FRANCE AND MARKETING PROSPECTS

by

M. ROZENHOLC

General Manager

NOVATOME

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1 INTRODUCTION

I first wish to thank the Japan Atomic Forum for inviting me to discuss the development prospects for fast breeder power plants.

This Forum is being held at an important stage in the Japanese breeder program, since Joyo has reached criticality and the Tokaï-Mura reprocessing installation has started operation.

The Commissariat à l'Energie Atomique and French industry participated in the initial stages of the Joyo project and the Tokaï-Mura reprocessing plant. We can therefore add, to our congratulations for the brilliant success achieved by our Japanese colleagues in this experimental phase symbolized by Joyo, our pleasure in the knowledge that these ventures, to which we made our modest contribution, are providing you with satisfaction.

The Japanese program is continuing with the Monju demonstration plant project. Consequently, your program is following a pattern similar to the one adopted by France, and this is not surprising. Japan's energy situation is closely comparable to that of France, explaining the common interest of our two countries in the earliest availability of fast breeder power plants.

In answer to your request, I shall discuss the situation and development prospects of breeder reactors in France. After touching on the reasons which make this development necessary, I shall draw a picture of the current state of our fast reactors in operation and under construction, and I shall indicate the prospects of commercial expansion of these power plants. The agreements signed in 1977, which I shall describe briefly, situate this forthcoming deployment within the scope of the cohesive unit formed by France, Federal Republic of Germany, Italy, Belgium and the Netherlands.

2 ENERGY RESOURCES AND THE NEEDS FOR FAST BREEDER REACTORS IN FRANCE AND EUROPE

2.1. The French energy situation

The French energy situation will be analyzed over a time interval of 25 years : 1976, 1985 and 2000.

In 1976, France consumed total energy resources equivalent to 175 million TOE, of which only 40,4 million were produced domestically. This corresponds to a 77% dependence on imports. These imports cost France 14 billion dollars in foreign exchange, amounting to 6% of the GNP and 23% of all our imports. In 1976, nuclear energy only accounted for 2% of total energy production.

By extending the horizon to the year 2000, we reach the table in Figure 1, based on a moderate growth rate (2.7% year) in energy consumption, with a significant rise in the share of nuclear energy, which will account for about 30% by the year 2000.

2.2. The energy situation of the main continental EEC countries

If we now look at the overall situation of the main continental EEC countries, in other words, Belgium, France, Netherlands, Italy and Federal Republic of Germany, we find the statistics in Figure 2, distinguished by a mean growth rate in energy consumption (2,5%/year) which is lower than that of France (in which per capita energy consumption is currently lower than the European average), with a sharp increase in the share of nuclear energy (20% by the year 2000).

2.3. The energy dependence of France and continental EEC countries on imports

The evolution of the pattern of energy dependence on imports (Figure 3) shows that France is one of the most dependent EEC countries, but that, by deliberate efforts in favor of nuclear energy, it is succeeding in lowering its dependence to the average level of the continental EEC, from 77% to about 60% by the year 2000 (it would have been over 90% without recourse to nuclear energy).

Figure 3 also shows that the total nuclear effort of the continental ECC will only succeed in stabilizing its dependence at slightly over 60% (instead of 80% without recourse to nuclear energy), which is still a considerably high figure.

This clearly illustrates the need for Europe to simultaneously implement all possible alternatives: diversification of coal and oil supply sources, recourse to new energies (solar, geothermal), incentives to energy economies and, naturally, reliance on nuclear energy.

2.4. Uranium supply of France and the continental EEC

The foregoing figures consider nuclear energy as a "domestic product". Hence they imply that uranium itself is a domestic product for the countries in question. We shall now see the true facts. The statistics in Figure 4 show the known and probable additional reserves which France and the continental EEC can consider as "domestic resources" at $50/lb. They show that these reserves fall far below requirements. In effect, if one considers that a 1000 MWe light water reactor consumes 5,000 tons of uranium during its average 30-year life span, we can see that the continental EEC resources of 230,000 tons will only allow it to supply total light water reactor capacity of 46,000 MWe. In actual fact, the French program alone calls for the commissioning of 55,000 to 60,000 MWe by 1990.

If, instead of these resources of 230,000 tons of uranium, we assumed (for the sake of argument) that the continental EEC could claim a share of world uranium resources (3.5 million tons) proportional to its "economic weight" in the world, this share would amount to 1.2 million tons. This would be adequate to supply light water reactors with a total capacity of 240,000 MWe, for a service life of 30 years. (Capacity forecast for 2000: 170,000 MWe).

But is it possible for responsible States to reasonably base their energy policy on the assumption that 4% of the world's population can consume 34% of the uranium resources?

This shows that if only light water reactors were employed, nuclear energy would only give the EEC a respite of a few decades.

In short, we can say that without resorting to nuclear energy, the energy situation of the continental EEC would be precarious, and that a nuclear program based exclusively on light water reactors would only provide short-term relief. Thus the question necessarily comes to mind: can we allow the enormous energy potential stored in plutonium produced by light water power plants to remain dormant? The Governments of the five EEC countries in question feel that this resource must be exploited. These are the reasons for the spread of breeder reactors in these countries, especially in France, and the grounds for the agreements which they concluded in 1977 in this area, and which I shall discuss later.

2.5. Breeders, a long lasting and needed energy source

Breeder reactors make it possible to derive maximum benefit from uranium by the use of a considerable portion of the energy potential of the isotope U_{238}. The orders of magnitude involved can be derived from the few statistics given in Figure 5. Figure 6 provides a comparative picture of the potential of the different energy raw materials employed. In a world threatened by shortages of conventional energy raw materials, of which a steadily growing share must be assigned to developing countries, the recourse of our countries, industrialized but poor in energy resources, to the potential of fast breeder reactors, becomes a matter of imperative need.

A few figures will illustrate the possible application of breeders in a country like France. To do this, one can examine the fissile material balance of a breeder reactor with a heterogeneous core on the life span (30 years) of a 1400 MWe power plant, an order of magnitude which will most probably be adopted for the capacity of the Electricité de France power plants to be built after Creys Malville. This balance is given in Figure 7.

One can see that it will first be necessary to load a core of about 3.3 tons of Pu 239 equivalent (about 4 tons of mixed Pu) and that a gain of about 7 tons can be achieved over a life of 30 years. This corresponds to a doubling time of about 17 to 20 years over the complete cycle, depending on the off-reactor down time. Based on these data, if one tries to visualize the penetration of fast breeder reactors, built in accordance with the availability of Pu from all sources (PWR + FBR) the calculations show that, by the year 2000, total capacity of more than 50,000 MWe could be installed in France, which is around the value to be installed in L.W.R. ten years earlier. One can see, taking shape, a scenario featuring optimum penetration of breeder reactors in a given nuclear program, with a gradual slowdown in the building of LWRs, which would be progressively supplanted by fast breeders. France would thus practically succeed in supplying its nuclear program exclusively with domestic uranium and with its mining concessions in Africa. The LWR/FBR breakdown would evidently depend also on other considerations, such as potential discoveries of uranium and the competitivity of breeder reactors.

3 BASIS OF INDUSTRIAL AND COMMERCIAL DEPLOYMENT

The industrial and commercial deployment of a series of nuclear power plants must be based on adequate technical experience and on industrial capability.

I shall therefore discuss the technical experience gained in France, and shall describe the industrial organization set up in the country and the international relations recently established in Europe for the promotion of this type of power plant.

3.1. Technical experience

Two liquid sodium fast breeder reactors are operating in France today.

(a) Rapsodie, a 40 MWt experimental reactor used as a fuel test bench, to determine fuel performance limits. Furthermore, it provides permanent proof that this type of reactor has stable and regular operation. Finally, it confirms that the primary circuit can be serviced after many years of operation. In 1977, after ten years of operation, the instrumentation plug, namely the structure which covers the core and supports the control rod mechanisms and the core instrumentation, was replaced. This carefully prepared operation proceeded without difficulty.

(b) Phénix is the demonstration plant serving as the basis for the prototype and commercial power plants to follow.

It is unnecessary to repeat the characteristics of this power plant since they have been described many times, and especially by Mr. Vendryes at this Forum in 1975. Briefly, it is a 250 MWe plant with three secondary loops, modular steam generators and integrated primary circuits.

The choice of integrated primary circuits was made essentially for safety reasons. In fact, reactor safety stems mainly from the effort to prevent accidents and incidents. A major safety element is thus the permanent core cooling; this implies the permanent immersion of the core in liquid sodium. The integrated or pool concept is a significant step in this direction, because the sodium can be contained in a vessel of the simplest shape, with welds which are easy to execute and inspect. The primary sodium is thus always confined within this vessel, instead of flowing through a long piping system. Figures 8 and 9 show the main operating data of Phénix from the date of industrial commissioning to the first leak observed in an intermediate heat exchanger in July 1976.

These data illustrate the many valuable lessons learned for subsequent development of this type of reactor.

Phénix has confirmed that this type of reactor is very stable and easy to control. It proved very easy to operate with only two secondary loops in service at 66% of rated electrical power. This confirms that the internal thermo-hydraulic problems of the primary circuit have been brought under control.

Phénix fuel has reached a maximum burnup of 66,500 MWd/t as compared with 50,000 MWd/t originally planned, without clad failure. These results remove any doubt concerning operation of the core structures under strong neutron fluence. Furthermore, the measured breeding gains are slightly higher than design figures. The two basic uncertainties which hitherto limited the use of breeders have thus been positively eliminated.

This type of reactor has a very low radioactive release rate. During its first two years of normal operation, the gaseous release rate was lower than 0.2% of the allowed rate, which was itself set at 1% of the concentration authorized by international commissions for population exposure.

Power plant personnel were subjected to average annual irradiation lower than 10 mRem per person, or 0.2% of the allowable dose.

These results, added to the fact that the gross thermodynamic efficiency of the installation is excellent, about 44.5%, show that this reactor has the least harmful effects on the environment.

In July 1976, and again in October 1976, leaks appeared at the top of two intermediate exchangers, and the power plant was shut down to repair them. Figure 10 shows a diagram of the unit, giving the location of the leak. Examination revealed that the leak occurred through a crack in the thick upper plate of the exchangers. This crack was caused by excessive local stress due to excessive differential expansion between the inner shell and the outer shell of the sodium duct leaving the tube bundle.

It was therefore decided to repair the six heat exchangers, two at a time. Between the removal periods, the power plant operated at 2/3 of capacity. Prior to working on the heat exchangers, they were washed and decontaminated with a decontamination factor of about 1,000. The residual activity of the components was very low, making it possible to work in direct contact with the parts to be dismantled and replaced.

Figure 11 gives the initial operating results during the repair period, and Figure 12 shows the values of radioactive release and personnel irradiation during the same period. These levels can be seen to be low.

This experience confirms the success of previous dismantling work carried out on the pumps and heat exchangers of Rapsodie, and on a pump of Phénix.

(c) The overall results provided by Phénix, both in relation to its good availability under normal conditions and the relative ease of service in case of incident, inspire confidence in the next step, Super-Phénix.

The Super-Phénix , Mark I, power plant at Creys Malville is the prototype of the commercial plants. Based on this plant, a decision was made to set up an industrial organization and regular commercial relationships. Thus the utility NERSA (51% EDF, 33% ENEL, 16% SBK) in March 1977 placed a turnkey order for the boiler (installed NSSS) with Novatome, acting jointly with the Italian company NIRA.

The main features and some characteristic values of the Creys-Malville NSSS are given in Figure 13.

It is emphasized that the integrated concept adopted for Phénix has been retained, since the operating results of this reactor and the experience provided by the Super-Phénix, Mark I, project showed that this concept can be drafted, built and installed without any special problem . However, the steam generator concept was modified. Super-Phénix, Mark I, features four generators, one per loop, whereas Phénix has twelve modules per loop. The experience gained and the results of many scale-model tests show that this choice, based on economical investment, is a sound one.

At the beginning of 1978, the progress of work on the site is as forecast. The basemat of the reactor building has been completed, together with the water intake installations in the Rhône, the walls of the reactor building are rising from the ground, the reactor vessel fabrication shop on the site is nearing completion (as shown by the slides).

With respect to the nuclear boiler, more than 80% of all sub-orders have been placed. Overall design studies are considerably advanced, fabrication design work has begun, material specifications have been written and supplies are under way. All component engineering will be completed in 1978.

The construction schedule currently planned for this power plant aims at reaching criticality in 1982 and industrial commissionning in 1983.

The first year of construction of the Creys Malville power plant has not revealed any grounds for reviewing the choices made. The construction of this prototype is and will be a difficult job. It requires the efforts of professionals. However, based on the experience gained by the operation of Rapsodie and Phénix, and on the competence of the research, engineering and construction teams, it has excellent chances of success today.

4. FRENCH INDUSTRIAL ORGANIZATION AND EUROPEAN AGREEMENTS REGARDING BREEDER REACTORS

4.1. Novatome

In France, the construction of the Super-Phénix NSSS for the Creys Malville power plant falls within the framework of subsequent EDF plans for this type of reactor: 8,000 to 10,000 MWe installed by 1992 and about 25,000 MWe installed by the end of the century.

An adequate industrial organization was set up in 1976/1977 in order to meet the following objectives :

- assume full responsibility for construction of the Super-Phénix nuclear boiler and also of the series of boilers which will follow this prototype,
- constitute the industrial link for the export of this type of NSSS,
- ensure the prerequisite continuity of the engineering teams which, as part of CIRNA and GAAA, guaranteed the success of previous French achievements in this area,
- ensure full integration of engineering and component fabrication. The degree of interdependence and interaction between the NSSS and the main components is such that the NSSS can only be designed and constructed under the impetus of a single industrial decision center, which is Novatome in this case,
- involvement in other advanced reactors (especially HTR).

In order to meet these objectives, the CEA and the main French suppliers of nuclear components (Creusot-Loire, Neyrpic, Alsthom-Atlantique) created Novatome, a joint subsidiary, in 1976/1977 (Figure 14). Creusot-Loire has a controlling interest in Novatome, is the industrial leader in the company's management, and provides it with support from its industrial resources particularly in the manufacturing of components.

4.2. Industrial organization in the EEC

Novatome has the following industrial counterparts in the "continental EEC".

- Belgium, Netherlands and F.R.G. : the company INB, of which the main shareholder is the German company Interatom, a wholly-owned subsidiary of KWU,
- Italy : The company NIRA, of which the main shareholder is AMN, of the Finmeccanica Group.

Novatome, INB et NIRA are bound by cooperative agreements.

4.3. European agreements relating to breeder reactors

The different countries of "continental EEC" find themselves in more or less the same situation from the standpoint of energy resources, a situation distinguished by the absence of fossil fuel on their territory, and by uranium resources on a scale making it necessary to use them as completely as possible by the use of breeders.

This community of interests naturally led to joint efforts in the development of breeder reactors.

F.R.G., Belgium and Netherlands have been bound for many years by agreements between research organizations, engineering companies and utilities, aimed especially at the construction of the SNR 300 power plant.

France and Italy have also completed joint research agreements between the Commissariat à l'Energie Atomique (CEA) and the Comitato Nazionale per l'Energia Nucleare (CNEN), as well as licence agreements between the CEA and NIRA.

These two groups came together in 1977 and concluded agreements in the following areas (Figure 15):

- pooling of knowhow and harmonization of research programs between the CEA (already harmonized with the CNEN) and organizations carrying out research in Federal Republic of Germany, Belgium and Netherlands;

- creation of a joint company under French law, the Société Européenne pour la Promotion des Systèmes de Réacteurs à Neutrons Rapides (SERENA) with the following shareholders:

  - a French system company, SYFRA (60% CEA, 40% Novatome) supplying the knowhow of France and Italy;

  - a German system company, KVG (51% Interatom, 19% GFK, 15% Belgonucléaire, 15% Neratoom) supplying the knowhow of Federal Republic of Germany, Belgium and Netherlands.

SYFRA has a controlling interest in SERENA. The latter is responsible for negotiating, granting and managing the licences deriving from this combination of knowhow.

These overall agreements thus gather the five countries of the "continental EEC" for exchanges at the research and engineering levels, as well as for the use of the knowhow pooled and transmitted to the licensees. Thus, efforts can be combined to complete the industrial development phase of this type of power plant in order to meet with greatest effectiveness the growing demand for electric power in the forthcoming decades.

This organization should not be considered as a closed one, because SERENA is ready to conclude suitable agreements with any interested organization.

As for the utilities of these countries, in 1974, they concluded an agreement aimed at joint construction and operation of two industrial scale breeder power plants.

This agreement was implemented by the creation of two subsidiaries of these utilities, one French and the second German. The former (NERSA: 51% EDF, 33% ENEL, 16% SBK) is responsible for ordering and operating the Creys-Malville power plant.

5 THE PROSPECTS FOR COMMERCIAL DEPLOYMENT

5.1. The situation after Greys-Malville

Electricité de France is the sole utility and is therefore responsible for installing the electric power plants designed to meet the needs of France.

Electricité de France has planned to establish fast breeder power plants in accordance with the availability of plutonium extracted from pressurized water power plants. EDF has thus drafted a program forecast calling for a commitment to two initial power plants in 1981, followed by a commitment to a series aiming at 8,000 to 10,000 MWe installed by 1992. This program could give rise to 25,000 MWe capacity by the end of the century.

NSSS design for the series following Super-Phénix, MARK I, began in 1975 with a set of preliminary studies, continued in 1976/1977 by extrapolation studies to an electrical capacity level of 1,800 MWe. This study was intended to determine the type and scope of the technological problems which will be raised by power plants of this power level.

Simultaneously, study work began, intended to achieve simplification in design, manufacturing and erection procedures, in order to reduce the investment costs of the power plants below the cost of the prototype.

These studies were carried out by EDF, Novatome and the CEA. The latter organizes its research and development program in accordance with the requirements revealed by these preliminary studies.

Preliminary studies for the first of the series were initiated in 1978. They are being carried out at the request of EDF, which is itself handling design of the conventional portion of the power plant. Novatome is carrying out preliminary studies of the NSSS with the participation of the Italian company NIRA and with the support of CEA teams.

The reference capacity of the power plant will be set in the course of 1978. This capacity will be greater than 1200 MWe, since preliminary studies have shown that extrapolation was technologically feasible, but it will not be very much over 1200 MWe, so that the series following Creys-Malville derives maximum benefit from the lessons learned in the design and construction of the prototype.

It should be added that in 1978, being exceptionally well placed to do so, Novatome and INB have decided, within the framework of their cooperation, to begin a comparative study of the pool and loop type reactors.

5.2. The fuel cycle

Simultaneously with NSSS studies, the CEA and COGEMA have begun preliminary design studies of fuel fabrication and reprocessing plants with a capacity of about 100 t/year, capable of fabricating and reprocessing the fuel from the first series of commercial reactors.

These design studies are based on the experience gained in prototype workshops currently existing within the CEA :

- in the area of fabrication, a prototype installation is operating at Cadarache, with capacity raised to 20 t/year. It fabricated all the cores of Rapsodie and Phénix and is geared to fabricate the first core of Super-Phénix, Mark I,
- in the area of reprocessing, the pilot installation of La Hague with a capacity of 1 kg/day, has reprocessed the fuel from Rapsodie, thus achieving the demonstration of a completely closed oxide fuel cycle.

  Another experimental installation with capacity of 10 t/year is also operating at Marcoule, and is making its contribution to the knowhow used in the 100 t/year specific plant project.

These fuel cycle plants specific of the fast breeder reactor series, will be initiated in accordance with the first series of commercial power plants.

5.3. Costs

The intended objective of the introduction of fast breeder power plants is obviously to lessen energy dependence by an attempt to achieve the most complete possible use of available uranium. This objective must be attained under acceptable economic conditions. In other words, the cost per kWh of the breeder will certainly have to be lower than that of the fossil fuel plants, most closely approaching the cost per kWh of the light water nuclear power plants.

Owing to its prototype character, the cost of the Creys-Malville plant is relatively high. This situation is not specific to fast breeder reactors, but is characteristic of the construction of every first major installation exploiting a new technique. The investment cost of the Creys Malville power plant is about twice the cost of a light water plant of equivalent size. To lower these costs, it is necessary to rely on the repetitive nature of subsequent power plant construction, and on simplification and technical progress.

A series of power plants will have to be built before the investment costs of fast breeder plants match those of light water power plants. The excess investment cost should be counterbalanced by lower fuel cycle cost.

Despite the difficulty of making comparisons of kWh cost between future power plants and those of today, some indications are already available:

- the share of operating cost (operation and fuel cycle) in the kWh cost of Phénix is already significantly lower than the kWh cost of fossil fuel plants (13 to 14 c/kWh) ,

- the kWh cost of Creys-Malville will probably closely approach the kWh cost of conventional plant burning desulfurized fuel,

- future variations in raw material cost will have no effect on the fuel cycle cost of a fast breeder plant, whereas a doubling of uranium cost gives rise to an increase of about 30% (about 1 c/kWh) in the fuel cycle cost of light water power plants, and a doubling of fuel oil cost is obviously fully applied to the cost of the fuel share of power produced by a conventional power plant (about 8 c/kWh),

- it seems reasonable to consider that between the pilot plant stage and the commercial scale plants for the fuel cycle, fabrication and reprocessing costs will go down significantly. In the meantime, the burn up will go up by a factor of 2. Under these conditions, it appears that the investment cost of the NSSS will drop sufficiently below that of Super-Phénix, Mark I, for the kWh cost of fast breeder plants to approach a level competitive with that of light water nuclear power plants.

These objectives, which will provide a long-term guarantee of electricity supply, independent of imports and related price fluctuations, at kWh costs comparable to present costs, are certainly not out of reach. They can only be achieved by the construction of a series of power plants, making it possible to benefit from the effect of repetition in the construction of the NSSS and from the full use of fuel cycle plants.

6 CONCLUSIONS

The knowhow gained by an extensive, coordinated research and development program has been exploited for the construction and operation of experimental and demonstration reactors.

This achievement will serve as a basis for construction of the commercial prototype from 1977 to 1983.

The early 1980s thus appear as the period of initiation of the commercial deployment of this series of power plants, the establishment of which is necessary to meet the energy needs of the nation.

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a.m. p.m. 12:00 Wednesday March 15.

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PERSPECTIVES FOR FAST BREEDER
ELOPMENT IN THE USSR

N. Krasnoyarov
USSR

resented at the meeting of Japan
strial Forum, March 14-16, 1978

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Fast breeders hold a prominent place among the reactors. Yoi know that their raw material resources base is tens times more that of thermal reactors. At present the sodium-cooled fast breeder reactors have been best developed. Among the countries making succesful steps in this direction is also Japan. I would like to congratulate my Japanese colleages with their success in the construction and opration of the experimental reactor "Joyo".

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STATUS AND PERSPECTIVES FOR FAST BREEDER REACTOR DEVELOPMENT IN THE USSR

N. Krasnoyarov
USSR

The paper presented at the meeting of Japan Atomic Industrial Forum, March 14-16, 1978

Scale of energy consumption is such now that it is very important to evaluate the existing natural resources. That is why the humanity is setting its hopes on the nuclear fuel and atomic energy.

Our country is rich in the fossil fuel reserves and there haven't yet been exhausted our hydraulic power resources. But the geographical distribution of the energy reserves is very irragular and their lesser portion is in the region with the predominant population and with the basic power consumers. For that reason our country had long ago chosen the path to develop nuclear power. Last years such nuclear power plants as Kolskaya, Leningradskaya, Armenian, Chernobilskaya ones were constructed and operate successfully. New power plants are planned and are under construction. The predominant development of nuclear energy is planned in the Europian part of the USSR. Scientists and engineers are designing nuclear plant for heating. Achivements if scince and engineering must be used for the sake of mankind, must help people to make their life better, the air cleaner, and the surrounding nature more beautiful.

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To remind you the history of the fast reactor development in the USSR I should say that it began with the construction of BR-2, a 100 kW plutonium reactor that reached the criticality in 1956 and with its physical coolant-free mock-up BR-1 that became critical in I955. At these reactors breeding was demonstrated experimentally. They have also demonstrated the possibility for a man to overide the fast neutron fission reaction.

By that time the theoretical calculations and experimental studies have made it possible to formulate the basic features for future power reactors:

- the ceramic fuel and
- the use of sodium as a coolant.

In I958 (twenty years ago) the new plutomium-dioxide-fuel sodium-cooled fast reactor BR-5 was constructed and became critical in Obninsk near Moscow. The main parameters of the reactor are close to those at the present plants: sodium outlet temperature is 500°C, power density is 500 kW/L even though the reactor capacity was only 5MW. Fuel testing, first oxide and subsequently carbide; the experience in operation with sodium contaminated with the corrosion and fission products; methods and techniques for detecting the failed fuel subassemblies; the experience in operation at power with the failed fuel subassemblies; thebehaviour of the radioactive products in the loops and equipment cleaning processes - that is an incomplete enumeration of information obtained at this reactor which was later (during I97I-I973) reconstructed for the sake of power increase.

The next 60MWth sodium-cooled fast reactor BOR-60 was constructed in Dimitrovgrad in the Middle Volga region. This reactor reached criticality in I969. It was already an experimental atomic power station with a three-circuit flowsheet capable to have higher sodium outlet temperature (up to 560°C), with higher power density (II00 kW/L and 500 W/cm) with a maximum fuel burnup to I0%:

- by this time more than 300 fuel subassemblies had been tested of which more than 200 had burnups over I0%, a maximum burnup was I7%;

- one 30 MW serpentine-type steam generator was tested under steam generation during I8000 hours. Subsequent examination of its tubes showed their perfect state;

- another modular-type steam generator made in Czechoslovakia is also approaching to 20000 hours of operation.

Safety problems took a special place during the operation and investigations at this reactor, the problems associated with sodium-water, sodium-air interaction, with the reactor transients, with the primary circuit fission product behaviour, the problems of the coolant decontamination and of testing the devices for monitoring impurities in sodium. In addition a great deal of studies on the material behaviour under high neutron irradiation fluences was carried out.

Sumaltanionsly with BOR-60 a large fast power reactor BN-350 was being constructed. It was brought into operation in July I973 in Shevchenko on the shore of the Caspian Sea. During I973-I975 this reactor was operating at powers up to 300 MWth producing steap for electricity generation and sea water desalonation. Since March I976 till present time the reactor has been steadily operating at 650MW-that is the highest power for breeder reactors in the world. The reactor provides I20 MW of electricity and 70 000m^3 of fresh water per day. The operational readiness of the plant is 90%. One of the steam generators has been successfully operating since first days and has already been under the load over 35000 hours. The troubles which had taken place in other steam generators during the initial operating stage permitted to demonstrate a good performance of the safety sistem and to gain the experience in cleaning and repair of the equipment, All other systems and components operate quite satisfactorily, the design characteristics were confirmed experimentally. Radiation conditions both in steady and transient states are very good; the radioactivity weist into the atmosphere about 0.5Ku/day for gases and IO^{-5}Ku/day for airsoles. The town Schevchenko is fully supplied with the fresh water from the desolonation plant. Grass, bushes and trees in pablic gardens are green in a modern town, that is growing in a desert.

This is a loop-type reactor, the heat from ints vessel is diverted through some piping loops. Japanese reactors "Joyo" and Monju" are of the same types.But a lot of specialists consider the pool type reactor tobe more compact and therefore more economic and safe. French reactor "Phenix", British PFR are the reactors of this type, In the Soviet Union such type of breeder reactor (BN-600) is under construction in Urals, at Beloyarskaya N.P.P. The reactor has been developed taking account of the requirements to improve the operating and power parameters as compared to the reactor BN-350. It has been designed to have higher sodium and steam temperatures, the capasity of 600 MW(e), I0% fuel burnup, longer operating periods between shutdowns. Taking account of the experience gained with the reactor BN-350 there has been exxentially improved the control system on the occurrence of sodium-water reaction. At present time the plant mounting is being continued:

- the main and emergency vessels are welded and tested;
- the supporting belt and shielding are installed;
- the secondary pumps and most of pimping and auxiliary sodium systems are mouted;
- power supply and control cables are now being mounted;
- heat exchangers and steam generators are being monufactured.

The main construction and mounting work is scheduled to be finished in I979.

After Comissioning of the reactor we shall have experience of construction and operation of two breeders, that are different. Both of them are steps on the way to future commercial power plant. Of course, very offen decisions about next steps are made after the end of preceeding ones. But designers and specialists are preparing new steps in advance. Such job was carried out in the USSR last years and seurch of optimal decision for core, thermal flousheet, equipment, steam parameters may be considered to be accomplished.

Next step in the programm of FBR development will be BN-I600. Its power hight enough for a single unit in electrical net of the USSR. Two 800 MW turbine will be used, It will be pool type reactor, Many specific parameters are similar to BN-600.

Construction of the first BN-I600 will be in eighties. The better will be the succes with BN-350 and BN-600, the sooner can made right decisions about the next steps. It is the goal that Soviet scientist and engineers have in the development of fast breeder reactors for the sake of people.

(9)

EMBARGO UNTIL 3/15 a.m. ~~p.m.~~ 10:30

3/217
Final

THE U.S. BREEDER PROGRAM -- PAST, PRESENT, AND FUTURE

An Address
By
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Before the Session on

EVELOPMENT of the Fast Breeder Reactor -- Prospects for Commercialization
At
The Annual Meeting of the
Japan Atomic Industrial Forum
Tokyo
March 15, 1978

THE TOPIC OF THIS SESSION -- "DEVELOPMENT OF FAST BREEDER REACTOR - PROSPECTS FOR COMMERCIALIZATION" -- IS INDEED A CHALLENGING ONE FOR ALL OF US. IT IS ESPECIALLY CHALLENGING TO THOSE OF US WHO ARE RESPONSIBLE FOR PLANNING AND MANAGING THE U.S. BREEDER PROGRAM.

I AM HONORED TO BE A PARTICIPANT IN THIS JAPAN ATOMIC INDUSTRIAL FORUM CONFERENCE AND I BEAR THE BEST WISHES OF DR. GEORGE (WOODY) CUNNINGHAM, DIRECTOR OF NUCLEAR PROGRAMS, U.S. DEPARTMENT OF ENERGY. DR. CUNNINGHAM REGRETS THAT HE COULD NOT PERSONALLY ATTEND THIS CONFERENCE.

THE ROLE OF THE FAST BREEDER REACTOR IN THE U.S. ENERGY FUTURE HAS BEEN THE SUBJECT OF INTENSIVE DEBATE FOR MORE THAN FIVE YEARS. FEW NATIONAL ENDEAVORS HAVE RECEIVED MORE POLICY ATTENTION BOTH INSIDE AND OUTSIDE THE FEDERAL GOVERNMENT.

TO PLACE THE CURRENT OUTLOOK IN PERSPECTIVE, LET US BRIEFLY REVIEW THE EVOLUTION OF FISSION DEVELOPMENT POLICY IN THE U.S. OVER THE PAST SEVERAL DECADES.

EVOLUTION OF U.S. FISSION DEVELOPMENT POLICY

THE VAST POTENTIAL BENEFITS OF CIVILIAN APPLICATIONS OF FISSION ENERGY WERE RECOGNIZED IN THE LATE 1940'S. IT WAS ALSO RECOGNIZED, IN THOSE EARLY DAYS, THAT FOR FISSION POWER TO HAVE A LASTING, PRACTICALLY INEXHAUSTIBLE ROLE, A BREEDER REACTOR TECHNOLOGY WAS NECESSARY. DEVELOPMENT OF BREEDER REACTOR TECHNOLOGY BEGAN ALMOST IMMEDIATELY AND IN FACT, THE WORLD'S FIRST REACTOR PLANT TO PRODUCE ELECTRICAL POWER WAS A SODIUM COOLED FAST REACTOR, EBR-I, IN THE U.S. ELECTRICITY WAS FIRST GENERATED IN DECEMBER OF 1951 AND BREEDING WAS CONFIRMED SOON THEREAFTER.

THE POTENTIAL RISKS INHERENT IN FISSION ENERGY WERE ALSO RECOGNIZED IN THIS EARLY PERIOD. NEVER BEFORE IN OUR HISTORY HAS A TECHNOLOGY BEEN DEVELOPED AND DEPLOYED WITH SUCH CARE AND FORE-THOUGHT. OUR EXCRUCIATING LICENSING PROCESS AND OUR EMPHASIS ON CODES, STANDARDS, QUALITY ASSURANCE, SAFETY AND SAFEGUARDS IN ALL FACETS OF OUR NUCLEAR PROGRAMS ATTEST TO THIS. THIS HAS RESULTED IN A SAFETY AND ENVIRONMENTAL RECORD TO DATE THAT IS UNMATCHED BY ANY OTHER MATURE ENERGY TECHNOLOGY.

THE POTENTIAL FOR NUCLEAR WEAPONS PROLIFERATION WAS ALSO RECOGNIZED FROM THE OUTSET. THE EARLY OFFICIAL LITERATURE IS REPLETE WITH CONCERN FOR THE DIVERSION, FOR WEAPONS PURPOSES, OF FISSIONABLE MATERIALS IN CIVILIAN APPLICATIONS: THE SMYTH REPORT (NOVEMBER 1945), THE TRUMAN-ATLEE-KING PROPOSALS (NOVEMBER 1945), THE ANDERSON-LILIENTHAL REPORT (MARCH 1946), THE "BARUCH PLAN" (JUNE 1946), AND SO ON. THUS, THE PROLIFERATION ISSUE IS NOT NEW. THE PIONEERS IDENTIFIED THE ISSUE AND ASSUMED THAT TIMELY PROCEDURAL AND INSTITUTIONAL SOLUTIONS WOULD BE FORTHCOMING.

THE 1950'S -- PROMOTION OF CIVILIAN APPLICATIONS

FEDERAL NUCLEAR POLICIES AND PROGRAMS FORGED IN THE 1950'S WERE UNASHAMEDLY PROMOTIONAL. A SENSE OF POSITIVE THRUST AND ACCOMPLISHMENT, A PROBLEM-SOLVING ETHIC, PERVADED THE NUCLEAR ENTERPRISE. UNDER THE ATOMS FOR PEACE PROGRAM, THE U.S. PROVIDED NUCLEAR REACTORS, URANIUM FUEL, ENRICHMENT SERVICES AND TECHNICAL ASSISTANCE IN DEVELOPING

CIVILIAN NUCLEAR USES TO COUNTRIES WHO WOULD AGREE TO BILATERAL SAFEGUARDS TREATIES THAT PROHIBITED WEAPONS PRODUCTION WITH THE MATERIAL AND ASSISTANCE PROVIDED.

THE ATOMIC ENERGY ACT OF 1954, A SIGNAL LEGAL LANDMARK IN THE U.S., MADE IT POSSIBLE FOR THE PRIVATE SECTOR TO BUILD AND OPERATE NUCLEAR ELECTRICAL PLANTS. COMMERCIALIZATION OF NUCLEAR POWER WAS A NATIONAL GOAL. IN FURTHERANCE OF THIS OBJECTIVE, THE ATOMIC ENERGY COMMISSION LAUNCHED A COOPERATIVE POWER REACTOR DEMONSTRATION PROGRAM.

NUMEROUS REACTOR TYPES, INCLUDING THE LIQUID METAL COOLED BREEDER WERE UNDER CONSIDERATION, BUT THE TECHNOLOGICAL SUCCESS OF NAVAL WATER REACTORS AND THE EXISTENCE OF SUBSTANTIAL ENRICHMENT CAPACITY LEAD TO THE LIGHT WATER REACTOR (LWR) BEING THE FIRST CLASS OF REACTORS COMMERCIALLY DEPLOYED IN THE U.S. THIS OCCURRED IN THE EARLY 1960'S.

THE 1960'S -- U.S. EMPHASIS ON THE LMFBR

AS THE COMMERCIAL DEPLOYMENT OF LIGHT WATER REACTORS BEGAN, INCREASED ATTENTION WAS GIVEN TO PLANNING FOR THE NEXT GENERATION OF REACTORS. A MAJOR POLICY STATEMENT, "CIVILIAN NUCLEAR POWER - A REPORT TO THE PRESIDENT, 1962" - URGED INCREASED EMPHASIS ON THE DEVELOPMENT AND ULTIMATE DEMONSTRATION OF BREEDER REACTORS. AS A CONTINGENCY AGAINST POSSIBLE DELAYS IN THE BREEDER PROGRAM, CONTINUED WORK ON A VARIETY OF ADVANCED CONVERTER REACTORS WAS ALSO ENVISIONED.

SEVERAL YEARS LATER, AFTER EXHAUSTIVE TECHNICAL AND ECONOMIC ASSESSMENTS OF THE MOST PROMISING ADVANCED CONVERTER (ACR) AND BREEDER REACTOR TYPES AS WELL AS STRATEGIC COMBINATIONS OF VARIOUS REACTOR TYPES, THE FOCUS OF THE FISSION DEVELOPMENT PROGRAM WAS NARROWED TO AFFORD CONCENTRATION ON THE LIQUID METAL COOLED FAST BREEDER REACTOR (LMFBR). MARSHALLING AVAILABLE RESOURCES AND APPLYING THEM TO A SINGLE PRIORITY PROGRAM WOULD TEND TO ASSURE SUCCESS, WHILE CONTINUED DIFFUSE ATTENTION TO A SPECTRUM OF INTERESTING REACTOR TYPES WOULD NOT.

THE "CLASSICAL" FISSION DEPLOYMENT STRATEGY ADOPTED AT THAT TIME WAS BASED ON URANIUM/PLUTONIUM CYCLES AND RECOGNIZED THE LWR-FBR SYMBIOSIS:

- O THE PLUTONIUM STOCKPILES ACCUMULATED FROM LWR OPERATION WOULD BE USED TO START UP A BREEDER ECONOMY,
- O ENRICHMENT PLANT TAILS FROM THE LWR FUEL CYCLE WOULD BE USED AS FERTILE BLANKET MATERIAL FOR BREEDERS, AND
- O EVENTUALLY, DEPENDING ON GROWTH REQUIREMENTS, EXCESS PLUTONIUM PRODUCED IN FBR'S COULD BE USED TO SUSTAIN LWR OPERATION AND SUBSTANTIALLY REDUCE THE NEED FOR ENRICHED URANIUM.

IN THIS SCENARIO, BREEDER REACTORS WOULD DISPLACE LWR'S FOR NEW CAPACITY ADDITIONS AS NATURAL URANIUM RESOURCES WERE EXHAUSTED OR BECAME ECONOMICALLY RESTRICTIVE. PLUTONIUM INVENTORY REQUIREMENTS FOR NEW FBR CAPACITY WOULD ULTIMATELY BE SUPPLIED ENTIRELY BY EXCESS PLUTONIUM GENERATED BY THE FBR'S THEMSELVES. SINCE FBR'S REQUIRE NO ISOTOPIC ENRICHMENT OF URANIUM, NATIONAL ENRICHMENT PLANT CAPACITY

REQUIREMENTS WOULD ULTIMATELY VANISH. AS ENRICHMENT TAILS WERE EXHAUSTED CENTURIES HENCE, REMAINING LOW GRADE - HIGH COST NATURAL URANIUM (UNECONOMIC IN LWR'S) COULD BE EXPLOITED FOR FBR FERTILE MAKEUP REQUIREMENTS SINCE THE FBR WOULD USE ONLY NEGLIGIBLE AMOUNTS OF ORE.

THIS, THEN, WAS THE "CLASSICAL" STRATEGY WHICH EMERGED AS U.S. POLICY IN THE 1960'S: USE OF THE URANIUM/PLUTONIUM CYCLE, AND EXPLOITATION OF THE LWR-FBR SYMBIOSIS. THE CLASSICAL STRATEGY DID NOT EXPLICITLY CONTEMPLATE THE USE OF THORIUM, ALTHOUGH IT WAS RECOGNIZED THAT THE URANIUM RESOURCE BASE COULD BE EXTENDED BY USING THORIUM IN FBR BLANKETS OR IN ACR'S.

THE 1960'S SAW THE START UP AND SUCCESSFUL OPERATION OF EBR-II, SEFOR, AND THE COMMITMENT TO A HIGH PERFORMANCE FUEL AND MATERIALS TEST FACILITY -- THE FAST FLUX TEST FACILITY (FFTF).

AN UNSUCCESSFUL STEP TOWARD COMMERCIALIZATION OF THE BREEDER, FERMI-I, WAS ALSO MADE IN THIS TIME FRAME, UNDER THE POWER REACTOR DEMONSTRATION PROGRAM. REACTOR PLANT DESIGN, CONSTRUCTION AND OPERATION PROVIDED VALUABLE EXPERIENCE, BUT COMMERCIALIZATION WAS NOT YET IN SIGHT. THE SUBSEQUENT PROGRAM PHILOSOPHY THAT EMERGED IN THE LATE 1960'S COULD BE CHARACTERIZED AS <u>DELIBERATE</u> AND <u>THOROUGH</u>: A BROAD BASE TECHNOLOGY PROGRAM UNDERLYING AN INCREMENTAL APPROACH TO SCALING UP THE LMFBR CONCEPT TO MATURITY.

PLANS WERE MADE FOR ONE OR MORE PLANT DEMONSTRATION PROJECTS -- THE FIRST BEING AN INTERMEDIATE SIZE PLANT IN THE 300-400 MWE RANGE WHICH ULTIMATELY BECAME THE CLINCH RIVER BREEDER REACTOR PLANT (CRBRP) PROJECT. IN 1971 THE PRESIDENT ASSIGNED THE HIGHEST PRIORITY TO THE BREEDER PROGRAM, EXPRESSED SUPPORT FOR A SECOND DEMONSTRATION PROJECT, AND ESTABLISHED A 1980 GOAL FOR DEMONSTRATING THE LMFBR AS A COMMERCIAL POWER PRODUCER.

THE 1970'S -- THE LMFBR DEBATE

IN THE 1971-1974 TIME FRAME, A NUMBER OF SERIOUS OBSTACLES TO EARLY COMMERCIALIZATION SET IN:

- THERE WAS INCREASED SENSITIVITY TO ENVIRONMENTAL AND SOCIAL IMPACTS OF ENERGY PRODUCTION IN GENERAL AND OF NUCLEAR ENERGY IN PARTICULAR;
- THE NEED AND TIMING OF THE BREEDER OPTION WERE VIGOROUSLY CHALLENGED;
- FFTF COST AND SCHEDULE AND CRBRP COST ESTIMATES BECAME MAJOR ISSUES;
- MANAGEMENT PHILOSOPHY AND EMPHASIS WITHIN THE LMFBR PROGRAM ITSELF WERE QUESTIONED (JUDGED AGAINST SUCCESSES OF OTHER COUNTRIES, THE U.S. PROGRAM APPEARED AMORPHOUS, LACKING DIRECTION, PURPOSE AND SCHEDULE);
- BREEDING PERFORMANCE TARGETS WERE DEBATED, AND THE RELATIONSHIP OF THE FUELS PROGRAM TO LARGE PLANT DESIGN EVOLUTION WAS QUESTIONED (IN THIS REGARD, A MAJOR ADVANCED FUELS PROGRAM WAS LAUNCHED IN 1974); AND

- o The creation of the Energy Research and Development Administration (ERDA), which absorbed the AEC, brought increased competition from other energy technologies for RD&D resources.

In 1972, the Atomic Energy Commission was directed by a Federal Court to develop a comprehensive LMFBR environmental impact statement. This ruling, based on the National Environmental Protection Act (NEPA) of 1969, required the scope of the statement to be a mature, deployed LMFBR economy as opposed to an assessment of impacts of individual plants and facilities.

Preparation of the EIS, the conduct of associated public hearings, and the response to both Government and public review of the statement, was an exhaustive and thorough endeavor spanning several years. This intensive open-forum review of the U.S. program was of value to all nations with breeder programs.

Environmental Statement Findings and a New LMFBR Program Plan and Schedule

The principal results of the EIS effort were the ERDA Administrator's findings that:

(1) A high confidence decision on the suitability of the LMFBR for large scale deployment could not and need not be made at that time, due to several residual uncertainties and issues; and

(2) The LMFBR program should proceed through the demonstration phase in order to support a high confidence decision.

BASED ON THESE FINDINGS, A HIGHLY FOCUSED AND INTEGRATED PLAN WAS FORMULATED AND ADOPTED IN 1976. ITS MAJOR FEATURES WERE:

- RESOLUTION OF MAJOR ENVIRONMENTAL, TECHNICAL, AND ECONOMIC ISSUES BY 1986
  - INTERMEDIATE SCALE DEMONSTRATION OF THE COMPLETE LMFBR ENERGY SYSTEM, INCLUDING THE POWER PLANT AND ITS SUPPORTING FUEL CYCLE
  - A BETTER ESTIMATE OF THE EXTENT AND QUALITY OF THE URANIUM RESOURCE BASE
  - RESOLUTION OF REMAINING HEALTH, SAFETY, AND ENVIRONMENTAL ISSUES
- ESTABLISHMENT OF A STATE OF PREPAREDNESS, SHOULD A DECISION BE MADE IN 1986 TO DEPLOY THE BREEDER.

TO QUANTIFY AND SCHEDULE THIS STATE OF READINESS, THE PLAN WAS DRIVEN FROM THE FAR END BY URANIUM SUPPLY AND LWR CAPACITY GROWTH ASSUMPTIONS. THESE ASSUMPTIONS WERE:

- A U.S. URANIUM RESOURCE BASE OF 3.7 MILLION ST U_3O_8, AND
- A NUCLEAR CAPACITY OF 600 GWE IN THE YEAR 2000.

THUS, ASSUMING 0.3% ENRICHMENT TAILS ASSAY, URANIUM RECYCLE, BUT NO PLUTONIUM RECYCLE IN LWR'S, FEW LWR'S COULD BE COMMITTED FOR CONSTRUCTION BEYOND THE EARLY 1990'S, THAT IS, FEW LWR'S WOULD COME ON LINE BEYOND THE YEAR 2000.

THE LWR TO LMFBR TRANSITION COULD NOT BE ABRUPT, HOWEVER. TO ALLOW FOR AN ORDERLY LMFBR DEPLOYMENT, THE FIRST LARGE COMMERCIAL UNIT WAS ASSUMED TO COME ON LINE IN 1993, WITH A BUILD UP TO 30 GWE IN THE YEAR 2000. FUEL CYCLE CAPACITY TO SUPPORT THIS SCHEDULE WAS ALSO

ASSUMED IN THE PLAN. SLIDES 1 AND 2 SUMMARIZE THE CONSTRAINTS, DRIVING FORCES AND SCHEDULES IN THE 1976 LMFBR PROGRAM PLAN.

THE CENTRAL PATH OF THE PROGRAM WAS THE SCALEUP OF TECHNOLOGY THROUGH THE SEQUENCE OF POWER PLANT AND FUEL CYCLE DEMONSTRATION PROJECTS. ALL ELEMENTS OF THE PROGRAM WERE DRIVEN BY REQUIREMENTS AND SCHEDULES OF THE DEMONSTRATION PROJECTS. WITH THIS MANAGEMENT STRUCTURE, PROGRAM PERFORMANCE WAS MORE DEFINABLE AND MEASURABLE.

TO REEMPHASIZE THE UNDERLYING POLICY PRINCIPALS -- THE 1976 LMFBR PROGRAM PLAN REQUIRED BOTH

- RESOLUTION, ONE WAY OR ANOTHER, OF OUTSTANDING ISSUES BEFORE DEPLOYMENT COULD OCCUR; AND
- A STATE OF READINESS SHOULD DEPLOYMENT BE REQUIRED.

LMFBR PROGRAM REDIRECTION IN 1977

BUT THE 1976 LMFBR PLAN HAD TWO BASIC FLAWS:

- IT DID NOT ANTICIPATE THE FALL OFF IN NUCLEAR DEMAND OVER THE PAST SEVERAL YEARS, AS INDICATED BY DECREASED LWR ORDERS; AND
- NEITHER IT, NOR THE EIS ON WHICH IT WAS BASED, TREATED EXPLICITLY AND CONCLUSIVELY THE PROLIFERATION ISSUE.

IN APRIL 1977, THE PRESIDENT DEFERRED COMMERCIAL REPROCESSING AND FURTHER DEMONSTRATION OF THE PLUTONIUM BREEDER. AT THE SAME TIME HE EMPHASIZED COMPLETION OF THE JOB IMMEDIATELY BEFORE US: CONTINUED COMMERCIAL APPLICATION AND VALIDATION OF THE LWR TO MEET OUR EXPANDING DOMESTIC ENERGY NEEDS.

LET US EXAMINE THE BASIS OF THIS NEW POLICY THRUST. FIRST, THERE IS IMPLICIT IN THIS POLICY A LESSENED SENSE OF URGENCY FOR THE DOMESTIC USE OF THE BREEDER. RECALL THAT THE 1976 PLAN ASSUMED ABOUT 600 LWR GWE ON LINE IN THE YEAR 2000, RESULTING IN A NEED TO START DEPLOYING THE BREEDER IN THE 1990'S, PENDING A FAVORABLE DECISION IN 1986. THE CRBRP AND PROTOTYPE PLANT SCHEDULES WERE GEARED BOTH TO THE 1986 DECISION AND TO THE YEAR 2000 ASSUMPTIONS.

BUT THE FALL OFF IN LWR ORDERS OVER THE PAST FEW YEARS TEND TO MAKE THE 600 GWE FIGURE SOMEWHAT OPTIMISTIC. THE NEW FIGURE USED FOR PLANNING PURPOSES IS ABOUT 380 GWE IN THE YEAR 2000. BUT, AS SHOWN ON SLIDE 3, IT IS CLEAR THAT WE ARE NOT ON A TRAJECTORY TO ACHIEVE EVEN 380 NUCLEAR GWE IN THE YEAR 2000.

THE TOTAL COMMITMENT OF URANIUM RESOURCES ASSOCIATED WITH 380 LWR GWE IS ABOUT

o 2.6 MILLION SHORT TONS U_3O_8, ASSUMING NO RECYCLE; OR
o 2.2 MILLION SHORT TONS, ASSUMING RECYCLE OF URANIUM.

THESE FIGURES ARE TO BE COMPARED TO CURRENT U.S. ESTIMATES OF 4.5 MILLION SHORT TONS OF U_3O_8 TO $50 PER POUND. THIS LINE OF REASONING TENDS TO LESSEN THE URGENCY FOR BREEDER DEPLOYMENT IN THE U.S.

THERE ARE A NUMBER OF FACTORS UNDERLYING THE FALL OFF IN LWR ORDERS. AS WITH THE INTRODUCTION OF ANY NEW TECHNOLOGY, LWR DEPLOYMENT HAS SUFFERED THE EFFECTS OF BOTH INSTITUTIONAL AND TECHNICAL GROWING PAINS. WHAT THE PRESIDENT'S POLICY SUGGESTS TO THE U.S. NUCLEAR COMMUNITY,

THEN, IS THAT WE FINISH WHAT IS ON OUR PLATE NOW -- SOLVE THOSE PROBLEMS WHICH ARE INHIBITING FURTHER GROWTH OF LWR CAPACITY. FOR WITHOUT FURTHER SIGNIFICANT DEPLOYMENT OF LWR'S, THE ADVANCED REACTOR QUESTION IS LARGELY IRRELEVANT. THE PRESIDENT HAS UNDERSCORED THE IMPORTANCE OF THE LWR AS A RELIABLE ENERGY PRODUCER THAT CAN GO QUITE FAR IN MEETING OUR NEAR TERM ENERGY NEEDS WHILE WE RECONSIDER AND PLAN OUR ADVANCED FISSION AGENDA.

THE SECOND PRINCIPAL REASON FOR THE BREEDER DEFERRAL WAS THE INCREASED ATTENTION TO THE PROLIFERATION ISSUE. REPROCESSING AND RECYCLE, WHILE OF MARGINAL NATIONAL BENEFIT TO AN LWR-ONLY SYSTEM, ARE ABSOLUTE MUSTS FOR A BREEDER ECONOMY. STRIPPED TO THE ESSENTIALS, THE U.S. POLICY URGES A PAUSE IN CONVENTIONAL REPROCESSING DEPLOYMENT, IN ORDER TO EXAMINE TECHNICAL AND INSTITUTIONAL WAYS TO MINIMIZE THE PROLIFERATION POTENTIAL OF THE NUCLEAR FUEL CYCLE. THE U.S. POLICY INCLUDES INDEFINITE DEFERRAL IN COMMERCIAL REPROCESSING AND THE PLUTONIUM BREEDER IN ORDER TO REVIEW THE NECESSITY FOR AND ALTERNATIVES TO BREEDER REACTORS AND PUREX REPROCESSING. THE DEFERRAL IS THE IMMEDIATE PROBLEM; HOWEVER, THE LARGER ISSUE IS SEEN TO BE PROLIFERATION RESISTANCE IN THE PLUTONIUM ECONOMY.

THE ADMINISTRATION SEEKS AN INTERNATIONAL CONSENSUS ON THE

- UNDESIRABILITY OF FURTHER NUCLEAR WEAPONS PROLIFERATION; AND
- ON THE FORM AND MANAGEMENT OF FISSION ENERGY FOR CIVILIAN APPLICATIONS. TO FURTHER THIS OBJECTIVE, THE INTERNATIONAL FUEL CYCLE EVALUATION (INFCE) WAS LAUNCHED LAST YEAR.

THE CURRENT U.S. LMFBR PROGRAM

U.S. REPROCESSING AND BREEDER DEMONSTRATION SCHEDULES HAVE BEEN SUSPENDED. LMFBR PROGRAM PLANS AND SCHEDULES BEYOND FFTF WILL AWAIT THE OUTCOME OF INFCE.

THIS IS NOT TO SAY THAT OUR LMFBR EFFORT HAS BEEN ABANDONED IN THE U.S. ON THE CONTRARY, A STRONG, WELL FUNDED BASE TECHNOLOGY EFFORT REMAINS AND WILL CONTINUE UNTIL INSTITUTIONAL OR TECHNICAL SOLUTIONS, OR BOTH, CAN BE FOUND TO MINIMIZE OR ELIMINATE THE PROLIFERATION RISK. AN LMFBR OPTION WILL BE MAINTAINED. PROGRAM FUNDING IS AS LARGE OR LARGER THAN THAT OF OTHER MAJOR LMFBR PROGRAMS. OUR ENDOWMENT OF ENERGY RESOURCES AFFORDS US THE OPPORTUNITY TO BE DELIBERATE AND THOROUGH.

THE CURRENT U.S. PROGRAM EMPHASIZES INTENSIVE WORK ON ADVANCED AND ALTERNATIVE FUELS. THE PLAN ALLOWS FLEXIBILITY IN CHOICE OF FUEL AND FUEL CYCLE, INCLUDING

- VARIATIONS ON THE CONVENTIONAL URANIUM/PLUTONIUM CYCLE, SUCH AS COPROCESSING AND SPIKING; AND
- URANIUM-233 PRODUCTION REGIMES WHICH COULD ALLOW BENEFICIAL COUPLING OF BREEDER AND CONVERTER REACTOR SYSTEMS.

IN PARTICULAR, WE FEEL THAT THE PROMISE OF HIGH GAIN FUELS AFFORDS US TIME TO DEFER BREEDER DEPLOYMENT WHILE EXAMINING NON-PROLIFERATION MEASURES.

IN ADDITION TO IMPROVED OXIDE AND CARBIDE FUEL SYSTEMS, METAL FUELS AND PYROMETALLURGICAL REPROCESSING ARE ALSO UNDER RECONSIDERATION.

SHORTLY, THE FFTF WILL BE COMING ON LINE, PROVIDING

- o A POWERFUL TOOL IN BREEDER FUEL AND MATERIALS DEVELOPMENT; AND
- o A BASELINE FROM WHICH TO SCALE UP HEAT TRANSPORT SYSTEMS AND COMPONENTS.

SODIUM SYSTEM HARDWARE DEVELOPMENT AND TESTING WILL CONTINUE TO HAVE HIGH PRIORITY IN THE U.S. WE VIEW THIS AREA AS BEING ON THE CRITICAL PATH TO A VIABLE LMFBR OPTION. THE PROLIFERATION ISSUE IS COUPLED LARGELY TO CHOICE OF FUEL AND FUEL CYCLE, AND IS ESSENTIALLY INDEPENDENT OF HEAT TRANSPORT SYSTEMS AND BALANCE OF PLANT. FOR THESE REASONS, THE DEVELOPMENT AND TESTING OF SODIUM SYSTEMS WILL BE PURSUED WITH VIGOR. THE U.S. EXPERTISE IN DESIGN AND MANUFACTURE OF SODIUM SYSTEMS WILL BE PRESERVED AND ENHANCED. OUR TESTING CAPABILITY AT SANTA SUSANA IS AMONG THE MOST ADVANCED AND FLEXIBLE IN THE WORLD.

FINALLY, ALL PROGRAM ELEMENTS WILL BE DRIVEN, FOCUSED, AND INTEGRATED BY AN LMFBR PLANT DESIGN EFFORT. THE TARGETED POWER RATING WILL BE IN THE 600-700 MWE RANGE -- A SIGNIFICANTLY LARGER SCALEUP THAN THAT OF THE CRBRP DESIGN. FUEL AND FUEL CYCLE FLEXIBILITY WILL BE AN EXPLICIT GOAL OF THIS DESIGN.

TO SUMMARIZE, FROM THE U.S. DOMESTIC VIEWPOINT, THERE APPEARS TO BE TIME TO DEVELOP A <u>BETTER</u> PRODUCT AND TO EXAMINE PROLIFERATION CONSIDERATIONS MORE DELIBERATELY. WE HAVE TO SET ABOUT TO DO SO.

3/27
Final

Management of Radioactive Wastes in the Federal Republic of Germany

H. Krause

Nuclear Research Center Karlsruhe

Introduction

In the Federal Republic of Germany, nuclear power reactors with a total capacity of about 7.4oo MWe, a reprocessing plant with an annual capacity of about 4o tons per year and plants for the fabrication of LWR-fuels, HTGR-fuels and mixed oxide fuels are in operation. Two large and four smaller nuclear research centers with several research reactors, accelerators, hot cells and many laboratories are in working. Radionuclides are widely applied in industry, medicine and research.

The radioactive wastes arising from these activities are treated in such a way that

- their volume is reduced to a minimum
- the remaining residues are transformed into solid products well suitable for final disposal
- and only innocuous amounts of radionuclides are released into the environment.

The radioactive residues are disposed of in deep geologic formations, thus excluding any contact with the biocycle [1 - 5]

Nuclear energy is expected to play an important role in the future energy supply. An installed nuclear power capacity of 2o - 3o.ooo MWe is anticipated in 1985.

To cope with the future demand on reprocessing and mixed oxide fuel fabrication, a big nuclear fuel cycle park will be built and should start operation around 199o. It will comprise a reprocessing plant with a throughput of 1.4oo t/y, a mixed oxide fuel fabrication plant with an equivalent capacity and plants ne= ry for the treatment of all radioactive wastes arising. The nuclear fuel cycle park will be erected on top of an appropriate salt formation enabling the final disposal of the waste residues below the site. [1 , 6]

An important R & D - program is under way to make the techniques available for the treatment and disposal of the wastes arising from reprocessing and mixed oxide fuel fabrication.

Low and medium level liquid wastes

The methods used (in the FRG) for the treatment of low and medium level liquid effluents are chemical precipitation, ion exchange and evaporation. The chemical precipitation is applied at some nuclear power plants for the treatment of low activity effluents with high contents of salts and dirt. The decontamination factors achieved are in the range of 2 - 1o.

In the power stations the very low active effluents arising e.g. from laundries and showers are usually only cleaned by filtration on settling filters.

~~In the FRG,~~ A large part of the low level and all medium level effluents are evaporated. The experiences gained so far are very good. Decontamination factors of $1o^4$ - $1o^6$ are achieved.

At the big nuclear research centers where cheap waste heat is not available, vapor compression evaporators are usually employed. At the Nuclear Research Center Karlsruhe, about 11o.ooo m^3 of radioactive effluents have been treated up till now in this type of evaporators. Vapor compression evaporators are very economic in operation as they are consuming no cooling water and almost no energy for heating. However, from our experience it turned out that their application should be restricted to low level effluents. With higher level wastes the maintenance leads to increased doses to the operators. ~~Nevertheless~~, lower doses could only be expected from units with a different construction principle.

Nuclear power plants usually employ natural convection evaporators. They are much less economic in energy and cooling water consumption but do not require almost any maintenance. Therefore, they are also used for the evaporation of higher active effluents.

Clean water with low salt content as from primary reactor coolants, fuel element storage ponds, or evaporator condensates, is usually decontaminated by organic ion exchangers [7 - 1o]

Due to the very effective decontamination processes employed, only very small amounts of radionuclides are discharged into the environment. The total amounts discharged annually in the whole Federal Republic with the liquid effluents is < 5 Ci. For comparison it should be noted that the total radioactivity of only the River Rhine originating from fall-out and naturally occuring radionuclides amounts to about 15o Ci (maximum 64o) per year [11]

Solidification of low and medium level liquid waste residues

Prior to final disposal the residues arising from the treatment of low and medium level liquid effluents have to be transformed into solid products which have to meet the following specifications:

- low solubility in water and salt brines
- good chemical resistance
- good resistance to irradiation
- not easily burnable or degradable
- formation of stable blocks with good mechanical strength.

At the time being mixing of evaporator concentrates, filter residues and ion exchangers with concrete is one of the methods employed in large scale 8 - 1o . The process is relatively simple and cheap x. ~~However~~ Anyway, cementation increases the volume of the residues by a factor of about 2, the hardening is sensitive to the chemical composition of the waste and the leach resistance is only moderate, especially for ~~nuclides~~ nuclides the Cs-137 (10^{-2} - 10^{-3} g · cm^{-2} · d^{-1}). Recent investigations ~~on the improvement~~ of the leach resistance by additi~~ons~~ves ~~, yet~~ gave improvements up till a factor 1oo.

Large amounts of liquid waste concentrates have also been incorporated into bitumen. In the Nuclear Research Center Karlsruhe ~~exclusively, There~~ e.g., 9oo m^3 of low and medium level concentrates with a total activity of 5o.ooo Ci have been incorporated into bitumen by a screw extruder, yielding 2.5oo drums with final product [8 - 1o, 12, 13]

The experiences gained so far with bituminization were rather good. The properties and the long term behaviour of the final products under different conditions have been thoroughly investigated. The leach rates of the final products are usually lower than those of cement by 1-2 orders of magnitude (10^{-4} g · cm^{-2} - d^{-1}, exept for products containing hydrate-forming salts), the volume is lower by a factor of 2 - 5.

x as long as the activity content is low. Higher active wastes require more sophisticated installations.

~~Our experiences indicate,~~ However, ~~that~~ thermally instable products should be excluded from bituminization.

Recently, a new process has been developed for the conditioning of spent ion exchange resins. A mixture of styrene-compounds with divinylbenzene and a catalyst are poured on wet ion exchangers. Within a few days a polymerization takes place and a solid block is formed [8] . The product quality is similar to that of bitumen-products. A mobile unit has been constructed by a private firm in which at different reactor stations about 6o m^3 of spent ion exchange resins have already been conditioned [14]

High level liquid wastes

Up till now, only small amounts of high level fission product solutions have arisen (~ 4o m^3). The German policy provides for a conversion of this type of waste into glasses or products of equal qualities after an appropriate cooling time. For the development of suitable products and processes, a large R & D - program is being carried out [15, 16] . Borosilicate glass blocks and phosphate glass beads embedded into a metal matrix, have been developed.

In the field of borosilicate glasses One of the objectives of the development works ~~of the borosilicate glasses~~ was to get a product which is not sensitive to variations in the waste composition and can incorporate all the relevant elements in sufficient concentrations. To examine the properties of the products developed, some real highly active glasses have been produced already, in total about 15 kg with a total activity of 44.ooo Ci. Investigations on micro- and macro distribution of the radionuclides, leach rates in water and salt brine, reactions between glass and salt, stored energy, helium build-up, recrystallization etc. have been carried out [17 - 19] . In time labs experiments with Cm-242 α -doses as they are expected in real high level glasses within 1o.ooo years have been applied to borosilicate glasses within about 2 years (2.5 · $1o^{12}$ rad). After this irradiation no significant deterioration of the glass quality has been observed. In other experiments the chemical compatibility of borosilicate glasses with plutonium and other actinides has been studied and their solubility in glass established.

The leach experiments have revealed, that the leaching is essentially a corrosion process which starts with a selective leaching of alkali ions, followed by a swelling, bursting and detachment of the thin depleted layer (≃ 1 m). After this, the process starts again. It has been demonstrated that the plutonium is well fixed in the detached high polymer siliceous matter, [19 - 22] so reducing largely its mobility, even after dissolution of the original glass [[illegible]]

It has been possible to convert glass glasses into micro-crystalline glass ceramics by addition of certain elements (e.g. Ti) and a special annealing program. These products are thermodynamically more stable than glasses [17, 19, 23, 24]

In the frame of the development of phosphate glasses active samples of 16 kg and a total activity of 38.ooo Ci have been produced so far. A part of them has been incorporated as beads into a metal matrix. The embedding of glass beads into a metal matrix leads to a reduced central temperature thus preventing devitrification of the phosphate glass during final storage. [25]

↕ enlargen distance ↕ ↕

For the conversion of high level liquid wastes into glasses three technical processes have been developed.

At Karlsruhe, the waste is mixed with fine glass powder, sprayed or dropped into a ceramic spray tower ~~and~~ heated to about 1.050°C. When spraying, the fine droplets dry out on their way down to the electrode heated ceramic melter below which is directly integrated into the calciner. ~~Every 8 hours,~~ The molten borosilicate glass is withdrawn and poured into a metal cylinder. The off-gas passes through a self-cleaning filter which is filled with small ceramic beads and maintained at temperatures of about 1.ooo°C so that the deposited fines ~~form a~~ melt and ~~molten glass whic~~h drop~~s~~ slowly back to the melter. In inactive pilot scale experiments, about 21.ooo l of simulated waste has been converted into 4.ooo kg of glass. [16, 19, 26]

The Gelsenberg company is operating a similar electrode heated ceramic melter into which the HLLW is fed together with the appropriate amount of phosphoric acid. The evaporation takes place on the surface of the melt. The phosphate glass is withdrawn continuously and passes through nozzles from where it drops onto a cooled rotating plate, forming glass beads. These are transported into a metal canister, which ~~later on~~ is filled up with a low melting metal (e.g. lead-alloys). The technique of embedding into a metal matrix was developed by Eurochemic. 4oo kg of glass have been produced so far in this unit [16, 25]

At Jülich, investigations are made on a drum drier from which the dried mixture of waste nitrates and glass forming additives is taken off by a blade and falls into a graphite crucible. In the crucible which ~~later~~ also acts as a final container, the mixture is molten to a borosilicate glass. In the course of the experiments about 5o kg of glass have been produced up till now [16, 27]

Recently the decision has been made to concentrate the German activities in the field of high level waste solidification to only one process until its hot demonstration. The PAMELA-process (Gelsenberg) leading to phosphate glass beads in a metal matrix has been selected for this purpose. For its implementation a cooperation contract has been concluded with Eurochemic.

Low level solid wastes

In the big nuclear research centers the burnable low level solid wastes and organic solvents are incinerated. At Karlsruhe, since 1971 about 8.000 m^3 of solid wastes and 150 m^3 of organic liquids have been burnt. ~~The scheme of the furnace is shown in table (I)~~ . Its special feature is the off-gas cleaning by ceramic filters at high temperatures. The ashes are incorporated into concrete. The overall volume reduction achieved was about 1 : 80. The average activity of the off-gases was $4 \cdot 10^{-10}$ Ci/m^3 β and $2 \cdot 10^{-12}$ Ci/m^3 α [8, 10, 28]

At the Jülich Center recently a furnace has been developed in which the wastes are burnt in an oxidation chamber after having been decomposed in an pyrolysis chamber situated above. The off-gases are cleaned by steel felt filters [29]

The non-combustible wastes, in the smaller plants also the combustible wastes are generally reduced in volume by baling. A volume reduction of 1 : 3 - 1 : 8 is being achieved by this process. The compacted pieces are pushed into a wire gasket inserted into a drum, the empty space is filled up with concrete grout.

At Karlsruhe, a special hot cell is available for the treatment of medium level solid wastes. There, they can be chopped into small pieces, sorted, packaged and inserted into concrete. A heavy duty manipulator and several remotely handled tools are available for this purpose.

Special wastes arising from reprocessing and mixed oxide fuel element fabrication

Up till now, only small amounts of α-bearing and high level ~~solid~~ wastes have arisen x. Therefore, in most cases it has been possible to treat them as, or together with ~~medium level~~ these

compared to low and medium level β / γ - wastes.

wastes. ~~Only a few waste streams have required special treatment methods~~. To cope with the needs of the planned big fuel cycle park, R & D - work in the field of ∝ -bearing and high level solid wastes is carried out . For the treatment of solid ∝ -bearing wastes a wet combustion process in a hot mixture of nitric and sulfuric acid is being developed [19] . It allows a relatively easy recovery of plutonium.[1]

For the treatment of cladding hulls investigations on baling followed by incorporation into concrete are carried out.[1] [30] Preliminary experiments on the treatment of feed clarification residues have started recently.

Furthermore, a process has been developed in which spent tributylphosphate (TBP) is separated from the diluent kerosene by extraction with concentrated phosphoric acid. The kerosene after purification on silica gel can be recycled into the reprocessing plant. The TBP is solidified by mixing with PVC. The process has been demonstrated with 2oo m^3 of real spent TBP since 1971 [13]

To avoid the volume increase of waste residues at the neutralization of spent nitric acid ~~liquid waste~~s prior to evaporation or solidification a process on chemical denitration has been developed. Formic acid is reacting with the nitric acid according to the equation:

$$2\ HNO_3 + 4\ HCOOH \longrightarrow N_2O + 4\ CO_2 + 5\ H_2O$$

Only gaseous reaction products and water are formed.

The process has already been demonstrated in active lab-scale experiments and in 9o inactive pilot plant runs with about 18.ooo l liters of nitric acid solutions [13, 31]

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[1] Work carried out in the frame of a research contract concluded with the European Community.

Principles of final disposal of radioactive wastes in rock salts

In the Federal Republic of Germany many years ago the decision has been made to dispose of the radioactive residues in to deep geologic formations. Disposal into the shallow ground is not envisaged. Sea disposal will only be carried out for wastes which are not suited for geologic but well suited for sea disposal.

For geologic disposal rock salt formations are favoured. They are found only on places well isolated from circulating water. The mechanical strength of the rock salt is similar to that of concrete and allows the excavation of chambers of some ten thousands of cubic meters and of cavities of even a few hundred thousand cubic meters which are stable without any support. The heat conductivity of rock salt is about 2 - 3 times higher than that of other rocks. This is important for the disposal of high level wastes. The most important property of rock salt with respect to safety is its plasticity when being under ~~high~~ pressure~~s~~. As a consequence, any pores and fissures if ever they should be ~~which may~~ formed become tightly closed by the plastic flow. In Germany there are numerous huge rock salt formations available.

Disposal of low and medium level wastes in the Asse salt mine

For the demonstration of the disposal of radioactive wastes the abandoned salt mine Asse II has been purchased by the Federal Government. In the frame of an experimental disposal program, since 1967 about 8o.ooo drums containing solid or solidified low level wastes have been stored there. Wastes with a dose rate below 1oo - 2oo mr/h on the surface are usually only packed in 2oo l drums; wastes with an outside dose ~~up to an~~ equivalent to ~~of~~ about 2 Ci Cs-137 are inserted into 4oo l drums and the free space filled up with concrete; wastes up to a dose rate of (+) ~~35 Ci Cs-137 equivalent~~ are packed into prefabricated concrete containers of 15 cm wall thickness.

(x) 15 r/h on the surface

According to the technique employed recently the drums are allowed to roll down a slope within the storage rooms and then covered with crushed salt. In this way, the waste drums are almost completely embedded in the salt. Once a room is filled, its entry is sealed by a concrete wall. The usuable volume of the rooms is usually about 36.ooo m^3 (6ox4ox15 m).

The medium level wastes are usually shipped to the shaft ft ← ~~shaft~~ of the Asse mine in large shielded containers holding 5 - 7 drums. After transfer into single shielding containers they are lowered through the shaft, transported to the charging room and from there ~~transfered~~ lowered to the disposal room situated below.

Up till now, about 1.3oo drums with medium level wastes have been disposed of by this technique. ~~The experiences gained so far have been excellent;~~ No major problems have been encountered. After filling the storage room will be sealed.

Although the principles of the storage techniques described above are quite simple and their fundamental safety obvious, the experimental disposal program will be continued for a couple of years until (full) demonstration on a large scale and over a sufficient long period of time. During this time, further improvements should be possible. [32 - 35]

To facilitate the disposal technique for medium level wastes a cavern is being excavated actually at the Asse mine into which the drums can be introduced without shielding via a bore hole from directly above ground. By this technique the transport of the heavy shielding casks through the shaft could be completely avoided and the throughput increased.

Actually investigations are made on a process in which evaporator concentrates and sludges are mixed with hydraulic binders and pumped into a salt cavity where they should form a solid monolithic block. Preliminary results are rather ~~good~~ promising.

If it is possible to demonstrate that the safety standards can be met, this process would be an interesting alternative to the actual technique of pouring the waste into drums and piling these up in the rooms of a salt mine. A precondition for this procedure is that the waste production and the final disposal are located at the same site [1]

Disposal of high level wastes in rock salt

High level wastes have not been disposed of so far. However, a large R & D - program has already been started in this field. It comprises experiments as well as the development of a large computer program on heat dissipation.)
(In field experiments with electrical heaters the theoretical results are examined.

The heat distribution and dissipation in the complicated system of rooms and pillars is already very well known as is the effect of variations of parameters. For illustration it should be mentioned that in case of

- a glass containing 2o % by weight of 1o years old fission products
- glass blocks of 2o cm diameter
- bore holes filled up to a height of 5o m with glass cylinders and
- distances of 2o m between the bore holes (hexagonal array),

the maximum temperature in the salt will amount to about 24o°C and the maximum temperature will be ~~obtained~~ reached after 36 years.

Besides this, safety assessments are made and the technical equipment for the handling of the high level waste is being developed. The first experimental disposal with a limited amount of high level waste is anticipated to start around 1984. The disposal will be carried out under conditions which assure retrievability. Large amounts of high level waste will have to be disposed of in the F.R.G. only towards the end of this century. [32 - 34]

Disposal into non-saline formations

To create another option for the final disposal of low and medium level, especially bulky waste, the suitability of an abandoned iron ore mine ~~near Salzgitter~~ for this purpose is being investigated. [32 - 35]

For the disposal of tritium liquids containing ~~tritium~~ without any burden to the environment, the injection into an exhausted oil lense close to the Karlsruhe Center is under investigation [36]

Conclusions

Large amounts of low and medium level wastes have already been treated and disposed of in the Federal Republic of Germany. It has been possible to treat these wastes in such a way that only innocuously small amounts have been released into the environment. By the treatment, the waste volumes largely have been reduced and the residues transformed into solid products well suitable for final disposal. They have been disposed of into a salt mine, thus preventing any contact with the biocycle.

Wastes arising from the reprocessing of spent nuclear fuel or from the fabrication of mixed oxide fuels are not treated yet on a large scale. For this type of wastes, a large R & D -program is carried out in lab- and pilot scale. The technologies and products developed in the frame of these program should ~~It has been proven that the management of radioactive wastes has the high degree of safety and availability which is adequate to its importance.~~ however be available in due time before the arise of large amounts of these wastes in the planned nuclear fuel cycle center.

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11th JAIF Annual Conference, Tokyo 1978

Nuclear Energy Policy in the Federal Republic of Germany

National and International Aspects

Dr. Manfred Popp

Federal Ministry for Research and Technology, Bonn

Let me first thank you cordially for the invitation to the 11th JAIF annual conference as well as for the opportunity to say a few words on the situation in Germany at the beginning of this panel discussion.

When I first saw the program of your conference I hat the feeling that it only needed a translation into German to become a most intersting and up-to-date program of a similar meeting in Germany. The problems which we are facing in nuclear energy policy these days - both with regard to national and international questions - are of remarkable similarity. And though this observation might be valid for many western countries, it certainly applies most to our two countries.

Since the beginning of the seventies, we have experienced a growing public concern about the possible hazards of nuclear energy. As a reaction, the Federal Government had launched what we called "The Citizens Dialogue" providing information on nuclear energy on various levels in writing or through public hearings and seminars. Despite these efforts the controversy grew stronger and resulted in a number of demonstrations and riots at proposed sites for nuclear power plants which partly exhibited great violence. In 1977, the great democratic parties so far unanimously in favour of nuclear

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energy entered into a controversial debate on nuclear energy themselves thus reducing the political influence of the main citizen's initiatives. In autumn 1977, conclusions were reached by the coalition parties and the Federal Government, so far widely accepted by the public which call for a utilization of nuclear energy as far as necessary after sufficient exploitation of the chances for energy conservation and improved domestic coal utilization. The government meanwhile has enforced its respective provisions for subsidies, which hardly can further be enlarged without endangering economic evelopment. Thus, we expect, and will need an increased nuclear energy utilization according to the growing energy demand which, however, develops more slowly as expected some years ago. There is, however, no doubt, that nuclear energy will have to play an important role in the future enrgy supply of our country which has no domestic energy source besides lignite and pit coal. Both will probably have to rely on nuclear process heat for future improved utilization. One of the problems of nuclear energy utilization in Germany however, is the fact that there are no domestic uranium deposits. Hence, the present uncertainties in uranium supply have formed an important argument by the nuclear critics In addition, they from the basic incentive for our breeder development programm which is carrying on apace and will certainly benefit from the close european cooperation ,recently enforced by the German-French contracts. The basic problem of nuclear energy utilization in Germany, howeve relates to the question of radioactive waste management. It is a general consensus among the government, the political parties, the experts, many courts, citizen's initiatives and wide parts of the public, that sufficient provisions will have to be made for the treatment and safe disposal of the waste before carrying on with a large nuclear energy program. Very often conditions are beeing requested which would result in a complete halt of nuclear

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energy utilization for many years. Such a moratorium was very close in 1977 and can again become a dangerous threat for our economy unless our provisions for the establishment of a fuel cycle centre exhibit sufficient progress. Completely different from the situation in many other countries, the simple storage of spent fuel elements is not being considered a sufficient answer to the waste management problem. With regard to the special problems of our densly populated country all relevant powers request a final answer to the waste problem. Today, this answer can only be given by our concept for the back-end of the fuel cycle, providing for reprocessing of spent fuel, special treatment of the separated fissionproducts, on-site burial of the solidified waste into deep underground salt formations, recyling of the regained Uranium, recyling of the breeded Plutonium (thus reducing the hazards aring from Plutonium stocks or Plutonium contents in spent fuel repositories and, of course, enhancing the energy output of the imported Uranium.) To repeat it in short: reprocessing is beeing considered a prerequisite for sufficiently safe waste management and that again is a prerequisit for further nuclear energy utilization

In deriving this policy we did not, of course, underestimate the problem of non proliferation of nuclear weapons. The Federal Republic of Germany has, as early as 1954, renounced the production of nuclear weapons. As in your country, which is the only one so far that had become a victim of nuclear weapons development, technologies for enrichment and reprocessing were developed solely for peaceful purposes. We have always adhered to the NPT and actively cooperated in the London guidelines. The design of our integrated fuel cycle center provides for the optimum protection against diversion. But we do not think that we would avoid reprocessing of fuel in a nuclear energy scenario which would be acceptable at least in densly populated countries.

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For reasons that I have explained we cannot even wait with our decisions. And I do not think that a complete deferral of reprocessing would solve the non proliferation problem, given the fact, that the knowlegde required for the misuse of this technique is widely available world-wide. Instead, we should work for internationally acceptable improvements of the technologies as well as for control mechanisms and search for international solutions of the organisational problems. I sincerely hope that the open-minded exchange of views that has been taken up in the International Nuclear Fuel Cycle Evalution will maintain its momentum and will lead to efficient practicable results.

I hope that the nuclear communities in all countries which have a major interest in the peaceful utilization of nuclear energy and the desire for improved international cooperative in this field, will support our present efforts.

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Japan Atomic Industrial Forum, Inc.

11th Annual Conference

March 14 to March 16, 1978

" A Route Toward the Harmonious Development of Atomic Energy Utilization "

" Public Acceptance of Nuclear Power in Germany "

Dr. Thomas Roser
Deutsches Atomforum e.V.
Bonn
Germany

Opposition against nuclear power is reputed to be particularly strong in Germany. ~~Names of~~ Small villages like Brokdorf and Wyhl have gained worldwide notority ~~renown~~ thanks to the massive and violent antinuclear rallies which took place there. ~~The~~ Antinuclear citizens' groups claim more than 3oo.ooo adherance. ~~Up to~~ 9o.ooo individuals intervene against a proposed nuclear power station. 2o to 3o thousand people gather at antinuclear rallies. Thus, to an outsider, public acceptance of nuclear power may seem extremely poor in Germany.

On the other side of the medal, Germany, without the support of any military nuclear program, has become one of the world's leading nations in the field of nuclear technology: Nuclear power stations of German design are being operated and built in many countries, Germany cooperates as an equal partner with several nations on such sophisticated technologies as enrichment, reprocessing or advanced reactors.

~~Is there a contradiction between these two trends? I do not think so and I shall try to explain why.~~ ~~The~~ Opposition against nuclear power in Germany is mainly the result of nuclear power's success ~~in Germany~~. Nuclear power ~~turned~~ is ~~into~~ a major public issue ~~only when it became apparent that~~ because it ~~was~~ is a reality of the present and a necessity for the future of my country.

The first nuclear power station was coupled to the German grid in 1961. Its electric output was 15MW. Today, 14 stations are operating with capacities up to 13oo MW. Germany's total installed nuclear capacity reaches 7.4oo MW. ~~and~~ It is therefore by and large identical to ~~the situation in~~ Japan's nuclear committment .

In 1977, nuclear power stations ~~have~~ generated almost 36 billions of kWh. They ~~have~~ contributed more than 11% to Germany's electricity production and nuclear energy ~~has~~ covered 3.2% of our primary energy consumption.

13 more nuclear power stations are under construction. Once completed, they will add another 15.ooo MW to Germany's power grid. However, at four of these stations construction work and commissioning cannot go on because of court injunctions stopping all the work on the site.

For further 8 units, construction permits have been applied for but not yet granted.

Nuclear power's ~~contribution~~ importance is not limited to covering the country's energy demand. Nuclear technology is, moreover, an important industrial activity in Germany:

To build a domestic nuclear power station constitutes a workload of some 45.ooo manyears on the labor market. To stop the nuclear program would lead to massive unemployment. And, German nuclear industry is selling roughly 4o% of its products abroad, thus helping the country to maintain its balance of payments and to buy raw materials which we do not have and industrial products which are cheaper or better abroad.

This is the reality of the present. For the future, nuclear power is a necessity if our country wishes to maintain its standard of living and to help improving the situation in less fortunate regions of the world.

Germany is a small but densely populated country. It is highly industrialized and has little own raw material resources. For more than half of our primary energy consumption (exactly 58%) we depend on imports. The dependency is most acute on oil which covers 52% of our energy demand. 95% of this oil have to be imported, only 5% are of German origin. This situation is very unlikely to change since our share in the oil bearing zones of the North Sea is close to zero.

A diversification of the supply basis is therefore ~~a~~ mandatory. ~~necessity~~. Nuclear power ~~alone~~ only can - for the time being - make a significant contribution to this goal.

Federal Government therefore agrees to prognostics ~~brought forward and~~ based on reasonable assumptions which claim that nuclear energy's share in covering Germany's energy demand should increase from todays 3.2% to roughly 1o% in 1985, 16% in 199o and 27% around the turn of the century. These percentages would correspond to installed capacities of 24.ooo MW in 1985 and 75.ooo MW in the year 2.ooo.

When looking at these impressive figures and when realizing that they correspond to some 6o nuclear power stations in Germany, 22 years from now, you may understand why nuclear energy is a public issue heavily debated in our country.

When discussing the actual status of this debate, two aspects have to be considered:
On the one hand ~~you have~~ there are the issues, the reasons, the pros and the cons, on the other hand ~~you have~~ there are the tactics and the strategies. Both aspects are of course intimately linked and can only be separated for the sake of the argument. And both aspects have, over the time, considerably evolved. Arguments brought forward and strategies used by the opponents and by the advocates of nuclear power are today much more sophisticated than 2o years ago when a few farmers had to be convinced to sell their ground for a nuclear research facility.

~~As sort of an anticipated conclusion in my remarks~~, ~~I would say that it seems fair to claim that~~. Today the discussion on nuclear power is closer than ever to the central and essential question: What contribution can nuclear power make ~~What has to be done~~ to secure world development and world peace? This is the real problem and both sides, the advocates and the opponents, have to ~~make their~~ focus their attention on ~~contribution to~~ its solution.

The arguments, the motives and the tactics of the nuclear opposition have considerably evolved over the years. The oldest form of opposition is the refusal of the local population to accept the nuclear site in the neighborhood. When looking more closely into it you discover however that this is basically not an antinuclear movement. This traditionally ~~Here a usually~~ agricultural society is eager to maintain ~~afraid of modifications of~~ its socio-economic structure. Not nuclear power but industrialisation is their nightmare. ~~More often than not~~ Nuclear sites are often selected in rural areas where the soil and its exploitation constitute the only wealth of the population. Their ~~This~~ opposition therefore is essentially an economic one and therefore could be settled through economic means. These local opposition groups are numerically by far the strongest and therefore very important. Moreover, since they lack an ideological background, they are subject to infiltration by ideologically motivated opponents.

Coordination between the local opposition groups is not very good. There exist in Germany at least two rivalling national associations of citizens'groups, the larger of which claims the adherence of almost 1.ooo local groups totalling more than 3oo.ooo members. Of course, only a few of these 1.ooo groups fight a nuclear installation, most of them have other environmental concerns.

~~The~~ Local groups voice their op~~p~~inions directly through mass rallies and site occupation, indirectly they use court action and lobbying of local politicans to attack a ~~kill the~~ project.

The environmental movement is the backbone of the nuclear opposition. Not because it is numerically strong - it is not - but because it furnishes the infrastructure:
The environmentalists devote their time and their money to their cause, they disseminate the bad news on nuclear power, they have an international network of information exchange and cooperation, they organize nationwide and even international meetings and events, they act as experts in public hearings, they file court suits and so on. They are full of good intentions, some times even admirable in their devotion but they lack ~~without~~ a comprehensive political concept. There are indications that ~~Maybe~~ the soft technology path will fill this ideological gap in the future.

There is finally there is a small - some 3 to 4 thousand persons in Germany - , but well organized, extreme left wing group among the nuclear opponents. This group strives to overthrow the capitalistic class society in order to replace it by a communist one. For them, the antinuclear movement is a vehicule to achieve this goal, not a goal in itself. For them, a nuclear power station is bad when in the hands of the capitalists, an atomic bomb is good when in the hands of the people. This group ~~tries to~~ infiltrates other movements in order to "educate" them. It aims at violent confrontation~~s~~ in order to create what they call a revolutionary situation and it works generally on a conspirative basis.

The public activities of the nuclear opponents and the echo they find in the media create the impression that major parts of the population are represented by these groups. This is not the case. All opinion polls show that more than half of the population is ready to accept nuclear energy - without however loving it - whereas some 30% oppose it, the remainder being indifferent.
At recent local elections, environmentalists, socalled green lists, have collected 1.2 % of the votes only.
Despite these results, the antinuclear movement has succeeded in deeply impressing the political parties and consequently Federal and State parliaments. It came as a surprise to political leaders to see that groups other

than parties ~~were~~ are able to formulate and to voice political opinions and to present them successfully to the general public. Therefore, in order to win back the leading role in the debate on nuclear energy and in order to integrate those antinuclear groups, the political parties had to give particular attention to their arguments. This - plus social problems caused by a sharp decline in coal consumption - lead in Summer 1977 to a situation in which the two governing parties were facing serious draft resolutions demanding for a nuclear moratorium at their respective party conventions in November 1977.

Thanks to reason and thanks to the trade unions, nuclear energy survived this assault. Nuclear power stations shall in the future continue to be parts of Germany's electricity supply system, provided however that they are required to cover what the politicians call the residual energy demand and provided that the waste is taken care of.

The trade unions had clearly voiced their fear that a nuclear moratorium would lead to energy shortage and employment problems.

What are the issues which nuclear energy is facing in todays' public debate?

Thanks to reason, nuclear power emerged alive from this assault. No nuclear moratorium has been nor will be voted in any foreseeable future. Nuclear power has been, during the last 12 months, heavily questionned in Germany. The realisation of the nuclear program has been delayed. But the country's decision to peacefully use nuclear energy has not been reverted.

Nuclear power stations will continue to be part of Germany's electricity supply system, provided, however, that they are necessary to cover the demand and that the waste is taken care of.

The close fear of energy shortage and unemployment has been stronger than the distant fear of radioactivity.

In this evaluation, the trade unions and their leaders have played a major role by clearly voicing their preoccupation about the economic consequences of a nuclear moratorium for their members and for the nation.

~~The total number of such issues is finite and even diminishing. Thermal pollution e.g. has competely disappeared from the list~~. At present, two issues hold the front line of the nuclear debate:

- are we able to get rid of the nuclear waste?
- will security measures lead to the nuclear police state?

The waste issue has been amply discussed in a previous session of this Conference and I shall not come back to it in detail. In its report to Parliament on this matter published November 3o, 1977, Federal Government ~~states~~ has stated that the nuclear fuel cycle center planned for a site at Gorleben in North-Eastern Germany and comprising facilities for fuel storage and reprocessing, for mixed oxide fuel manufacturing, for waste conditioning and underground waste disposal can be realized without reasonable doubt and will be apt for secular storage even of highly active waste.

It is ~~however~~ obvious that ~~many~~ nuclear opponents are aware of the decisive importance ~~fact that the realisation~~ of the fuel cycle center ~~is decisive~~ for the future development of nuclear power in Germany. They may ~~therefore~~ try to concentrate all their efforts on this focal ~~central~~ point.

The police state argument is a dangerous one, not because it is serious - which it is not - but because it is easy and fascinating.

A book called "The Atomic State" and written by a famous science writer is 1978's bestseller for non-fiction. The basic thesis of the book is ~~to say~~ that the security measures necessary to protect nuclear installations ~~not only~~ against damages from terrorism and sabotage as well as from ~~but also against~~ peaceful demonstrations and labor disputes will inevitably lead to the perfect police state. Not the murderer, but the victim is guilty: Not those who try to overthrow the social system are to be blamed but those who maintain it.

This thesis is obviously wrong ~~The contrary is true~~: not nuclear energy but energy shortage may lead to a police state. A world without nuclear power would soon be a world full of restrictions on energy consumption. These restrictions would ~~than be~~ have to be regulated by Government, controlled by the bureaucracy, enforced by the law. This would ~~then~~ be the police state. Many of us have lived through regulated restrictions during and after World War II and we still remember what they meant: hunger, fear, black market, suspicion, denunciation, police.

Let us make, ~~We should~~ in common, ~~make~~ all efforts to avoid ~~the return of~~ such situations to come back.

What can the nuclear advocates do to improve public acceptance of nuclear power?

I shall try here not to expose general princip~~als~~les but to relate our actual experience. However, three introductory remarks may be allowed:

~~However I would like to make a few general remarks.~~

First of all there are two things we cannot achieve and which therefore will not be worthwhile trying:

1. We will never succeed in convincing a dyed-in-the-wool nuclear opponent and we will never succeed in making people love nuclear energy. All we can reasonably ask for is the general public to stay immune against wrong arguments and biassed information and to show comprehension for the necessity and relative safety of nuclear power.
2. Within the general public, ~~the views on nuclear power of~~ specific target groups are of major importance for public attitude towards nuclear energy. I just mention teachers, journalists, politicians, policemen.
3. Efforts to gain public acceptance need a long breath. This does not exclude concentrated short term activities. They may even be necessary every now and then. The No-On-15 campaign for the California referendum in 1976 was such a case. Generally speaking however, public information on nuclear energy should be considered as a long term investment.

Turning now to the German situation, for the German Nuclear Forum - "Deutsches Atomforum" - ~~has as one of its statutory tasks the~~ information of the public on matters of nuclear energy is one of its main statutory tasks.

The ~~main~~ efforts made by the forum are ~~concentrated~~ focussed on ~~the~~ a public information program run by our Nuclear Power Information Group - Informationskreis Kernenergie -. ~~They~~ It aims at providing specific target groups -like opinion leaders, school teachers, police forces- with information material specially designed to help them in coping with the questions on nuclear power they may be faced with while discussing with their constituency, their students or other groups.

A public exhibit shown all over Germany at trade fairs and similar occasions brings the forum into close contact with the local population in particular in regions where nuclear power is an acute problem because a power station is planned or built there.

Our press service keeps close contacts with the media and ~~tries to~~ provides journalists with information material necessary for their work.

A working group composed of representatives of our members in charge of public relation work serves as a center of communication and coordination for all public information efforts made by our members mostly on the local level.

The forum also provides experienced public speakers and debaters to groups and clubs interested in presenting nuclear power to their members.

And, last but not least, the forum organizes special courses to train members of the nuclear community to better communicate their knowledge and their experience to a sometimes interested, sometimes hostile public.
This brings ~~us~~ me to a point of major importance:
In the last resort, the success of nuclear power will ~~not~~ depend neither on its economics nor on its safety, but on the confidence the public puts into the persons working in the nuclear field. If ~~the~~ nuclear specialists are ~~considered~~ recognized by the public as knowledgeable, open, convincing, and reli~~ba~~able, nuclear power will benefit from this.
If they are reputed mysterious and evasive, nuclear power will suffer. That is why one of the main efforts made by the forum and by the German Nuclear Society is directed at making all members of the nuclear community sufficiently well-informed and sufficiently courageous to openly profess their pronuclear convictions. This personal engagement of the nuclear people in the energy debate is in our view necessary not only for the success of nuclear power, but, moreover, for the survival of our society.
Public acceptance of nuclear power cannot be bought with money, we have to fight for it.

Mr. Aoki

Sandström氏の
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At first I would thank the JAIF ~~and its managing director Mr Mori~~ so very much for the invitation to present the Swedish nuclear situation to this distinguished audience. It is my first visit to Japan and I am extremely happy to be here.

There are many ~~similiarities~~ resemblances between your country and mine as to our energy situation. Both countries are heavily industrialised and are exceedingly dependent on imported fuel to supply our need of energy. And we have both and with progress put large efforts on nuclear power to try to get rid of our large dependance on oil.

But there is one big difference and this is the very peculiar political situation with regard to energy matters which we have since 18 months in Sweden. These months have been filled with so many strange meanders that I feel it very difficult to give you ~~an anything like~~ clear picture of the development and how matters now stand. I will, however, do my best even if I have not always a clear view of the situation myself.

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1978-03-08

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1978-02-24

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3/16 a.m. p.m. 12:00

THE NUCLEAR SITUATION IN SWEDEN

by Sten Sandström, AB Atomenergi
Secretary General, Swedish Atomic Forum

The nuclear program

When nuclear energy R&D started in Sweden during the latter half of the 1940's the aim was to try ~~investigate the prospects for this new energy source~~ to make the country as independent as possible of import of fossil fuel. Later a large and very ambitious nuclear power programme was launched ~~primarily to meet the expected demand of electricity when the exploitable part of the large Swedish hydro power resources would be exhausted in the early~~ seventies. The efforts were prosperous and Sweden succeeded - as the only country in the western world - to develop a commercial nuclear power light water reactor - the ASEA-ATOM BWR - without licence from the USA.

~~Milestones in the work were~~ a first Swedish built experimental reactor (1954), ~~a pilot plant for uranium extraction (1956), the nuclear R&D center at Studsvik,~~ and the first power generating and district heat producing Ågesta reactor (PHWR, 80 MW th) which was in operation 1963 - 1973 ~~and work with the Marviken project (direct cycle boiling heavy water reactor with internal nuclear superheating)~~. The central body for the work was the semi-state R&D company AB Atomenergi (from 1969 state-owned). The first nuclear power plant, Oskarshamn 1 (440 MW BWR), was ordered in 1965 ~~from ASEA (later ASEA-ATOM) by the OKG power group.~~ The plant started commercial operation in February 1972.

Several orders followed up to 1976 comprising eleven reactors with a total power of 9.040 MW. ~~Seven of these were ASEA-ATOM reactors and the other three were Westinghouse reactors.~~

At present Sweden has 6 reactors operating, totalling 3.760 MW, two reactors ~~of altogether 1 800 MW~~ are ready to start operation this spring, two ~~of altogether 1 815 MW~~ will be ready during 1979 and 1980, and two reactor units, ~~each of 1.050 MW,~~ are ordered and are so far being built on a slowed down rate.

Last year nuclear power generated 18.800 GWh or 21.5 % of the total Swedish electricity production of 87.600 GWh. ~~During the last quarter of the year nuclear power supplied as much as 30 % of the electricity production.~~ Hydro power is still the main source of electricity and supplied 53.000 GWh or 60.5 % while fossil fuel power supplied ~~15,800 GWh or~~ 18 %.

The average capacity factor of the six nuclear reactors was 63 % and the best figure was 88.8 % obtained by Barsebäck 2 which started commercial operation on July 1, 1977. ~~Since commercial production of nuclear power started in Sweden in 1972, 51,260 GWh have been generated up to December last year.~~

The total installed generating capacity is for the present abt 25000 MW ~~13,170 MW hydro power, 7,680 MW fossil power and 3,760 MW nuclear power.~~ The State Power Board's share is 45 %, the remainder is private or municipal. The nuclear power plants are located at four different sites around the south coast of Sweden, namely Oskarshamn, Barsebäck, Ringhals and Forsmark (Fig 1). Consequently, no cooling towers are used.

The public attitude

In the beginning nuclear power was looked upon very favourably by the public and there was only some minor local opposition at plant sites which, however, abated soon and gradually disappeared. When the Ågesta plant, which was located only three kilometres from urban settlement, was shut down after ten years of operation, the inhabitants in the neighbourhood even protested. They had found that the reactor had no inconvenient influence on the environment, while the nearby oil-fired plant, used when the reactor was shut-off for maintenance, brought about much annoyance.

In the end of the 1960's a more widespread interest in conservation of nature began to manifest itself in Sweden. ~~It started to deal with poisonous discharges from industries and sewage treatment works, etc but~~ and after some time the various environment groups which had been formed included ~~also~~ nuclear power in their programs of action.

A principal figure in the environment movement was Björn Gillberg founder of the Environment Centre ~~and the National Federation of Environment Groups~~ which acted as a roof organisation for the activities. ~~Other opposition groups are Friends of the Earth, Field-biologists, Alternative city groups etc.~~ Later some scientists also joined the opposition. One of these was the plasma physicist and Nobel-price winner Hannes Alvén who engaged himself very actively and contributed more than anyone else to make the nuclear opposition a more countrywide movement as he had a considerable influence on the public and the politicians. Among others he influenced the leaders of the Center party and in 1973 the party included abandoning of nuclear power as a major issue in its program.

Also the Communists, the smallest party in the parliament, turned against nuclear power which they could not accept in a capitalistic country. Thus nuclear power more and more became a political issue.

~~Nevertheless did~~ the parliament in the spring 1975 with a large majority approve the social democrat government's nuclear program of 13 reactors. ~~The moderate party(conservatives) supported to the program while the liberals wanted 11 plants only and the centerists and the communists voted no.~~

At the general election campaign in the autumn 1976 the nuclear debate became still more intensified, ~~and the anti-nuclear arguments widened. While earlier the main arguments were the influence of nuclear power on the environment, the risk for accidents and nuclear proliferation including terrorism now questions on the management and final deposit of high level waste, the total nuclear power economy and the consequence of nuclear power as leading to a centralized society and a police state etc were added. Further the need of nuclear power at all were called in question as new prognoses on the future energy demand - as a consequence of the international recession - indicated lower figures than those on which the parliament's decision in 1975 were based.~~

The usual argu-
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At the same time the anti-movement was split up. Björn Gillberg was heavily criticized for not acting vigorously enough and several groups left his environment centre and formed the Environment League which is more aggressive. ~~and also is clearly left wing sympathising although it declares itself to be non-political.~~

T~~he debate also led to that the environmental risks of~~ coal and oil and the ~~risks of being~~ dependent of a few oil exporting countries ~~were paid~~ increased ~~attention to which became a pro-nuclear argument~~. Nuclear power was however considered to be the all over-shadowing evil by the opponents and therefore ought to be abandoned as soon as possible/ Until the renewable energy sources especially solar, wind and biomass could supply sufficient energy it was proposed by the opposition that oil and coal should be used as an emergency expedient. ~~As to hydro power most of the opponents were of the opinion that~~ No further exploiting of should be made.

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The new government's policy

Then came the general election in the autumn 1976 which created a quite new situation. The opposition parties won and the social democrat government resigned after 44 years in government position. The new non-socialist government was formed by the anti-nuclear Center party with ~~eight members headed by~~ Prime Minister Fälldin, six Moderates, four Liberals - both parties pro-nuclear - ~~and a non political Minister of Justice.~~ Without delay it took two main energy political steps namely, to present a Bill of Nuclear Stipulation and to appoint an Energy Commission.

1 member of the
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According to the bill of nuclear stipulation which became a law last spring a reactor owner can be granted to start operating a reactor only if he has "either produced a contract which adequately provides for the reprocessing of spent fuel and has also demonstrated how and where the final deposition of the highly radioactive waste resulting from the reprocessing can be effected with absolute safety or has shown how and where the spent, but not reprocessed nuclear fuel, can be finally stored with absolute safety".

Special stipulations applied to the Barsebäck 2 reactor implying that it would not be allowed to operate after the end of 1977 unless the owner could present a contract on reprocessing before that date which could satisfy the government.

The energy commission was charged to prepare government proposals for an energy policy to be presented to the parliament in 1978. One of its task was to assess the safety aspects of nuclear power, including the management of radioactive waste. When making up the various alternatives for energy policy covering the period up to 1990 the commission should present at least one which excluded nuclear power. ~~In connection with each alternative the economy, the employment policy, the trade policy, the national emergency policy, the public health and the environment policy should be analysed. The commission was also instructed to analyse how the different alternatives would affect Sweden's dependence on the rest of the world as regards the energy supply.~~

The commission got a parlamentary composition supplemented with experts on environment matters and nuclear safety and representatives of the industry and the trade unions. It got a prominent government official as chairman. Five working groups of experts were established ~~representing research and development, safety and environment, energy supply, energy conservation and government steering measures.~~

The commission was asked to ~~present its report~~ conclude its work within 18 months i.e. 1 July this year at the latest to make it possible for the parliament to decide on a new energy program in the autumn of 1978.

Shortly after that the ~~commission~~ bill of nuclear stipulation had been ~~formed~~ presented the three nuclear power utilities i~~.e. the State Power Board, Sydkraft and Oskarhamn power group~~ established a project "Nuclear Fuel Safety" (KBS) the aim of which was to prove that the demands and conditions in the nuclear stipulation law could be fulfilled. ~~Strategies for waste management were to be studied including final deposition of nuclear waste from reprocessed fuel as well as direct final deposition of non-reprocessed spent reactor fuel. The KBS project started with a budget of 40 million Skr which was later increased to 56 million Skr.~~ The main objects to be studied were encasement techniques, geology including hydrogeology and seismology. An inactive test station was put up in an abandoned mine. Considerable efforts were of course also to be made on safety analysis and repository design studies. The project got a budget of 56 million Skrs finally employed over 450 professionals and scientists.

The disagreement within the government on the nuclear power question became evident from the beginning. The first time it became apparent was when the Center party members in the government tried to prevent fuel loading and start of operation of the Barsebäck 2 reactor but without success. Since then the government has had to compromise each time something ~~was~~ were to be decided and the government policy has therefore been to let all important decisions rest for the time being with reference to the nuclear stipulation law. This has lead to that so far no decisions have been taken about the ~~two~~ reactor~~s~~ Ringhals 3 ~~and Forsmark 1~~ although ~~they~~ it ~~are~~ is now ready for start of operation. Each day the commissioning of one of these reactors is postponed has been estimated to cost Sweden about one and a half million Skr. The government's indecision has however had much more serious consequences not only for the Swedish nuclear industry but also for all industry as many initiatives and industrial investments have been put off owing to the uncertainty of whether the need of electricity for the planned project could be guarantied in the future. ~~The government has been very heavily criticised for its policy not only by the social democrat party but also in most of the leader columns in the press.~~ As far as energy R&D is concerned the government could, however, agree on the grants for 1977-78 within the present energy program. Some modifications were made to the effect that the grants for nuclear energy were lowered and the grants for the renewable energy sources were considerably increased.

The latest development

The situation for the present is the following:

1. In November last year the owners of Barsebäck 2 asked for permission to continue to operate the plant after 31 of December referring to a reprocessing agreement on nuclear fuel with Cogema in France. ~~The Nuclear Power Inspectorate as well as the Institute of Radiation Protection had approved the agreement and~~ The government finally gave its approval in the end of December. At the same time it stated, however, that no reprocessing was allowed before 1980. This decision does not matter as far as Barsebäck is concerned as no fuel will be ready there for reprocessing until 1980.

2. In the beginning of December 1977 the Nuclear Fuel Safety project presented its first report to the government on the final deposition of high level nuclear waste. The intention is to keep all spent fuel for 10 years in a central storage placed in a rock cavity. ~~This new storage is planned to be ready for operation in 1983-84.~~ After 10 years the fuel is sent for reprocessing to Cogema in France.

No high level waste will be returned to Sweden until 1990 at the earliest. It will be in the form of glass contained in cylinders of special steel. The cylinders will be placed in an intermediate storage facility in a rock were they will be air-cooled and kept in dry conditions for at least 30 years. The cylinders are then encapsulated with lead an titanium and transfered to an ultimate storage in a rock cavity 500 meters under ground. When the final deposit will be closed all cavities will be filled up with a buffer material consisting of quartzsand and bentonite.

Comprehensive studies have been made to find out how soon the radioactivity can leach out to the surroundings. Not until after about 1 000 years would it be possible to trace any radioactivity in a well bored in the neighbourhood of the deposit and the maximum radiation dose in such case - 13 millirems/year - will not be reached until after about 200 000 years.

The report has been sent by the government for comments to about 25 organisations. ~~The Project has stated that it considers that the described method meets the demand for safe final deposit of high level waste by the Nuclear Stipulation Law.~~

A report on safe final deposit of non-reprocessed nuclear fuel will be presented this spring. It has been indicated that the method will be at first to keep the fuel elements for 10 years in a central storage. The~~y~~ fuel rods will then be contained in copper cylinders filled with lead and the cylinders will be placed individually in rock cavities 500 meters below the ground which will then be filled with bentonite.

3. Preliminary reports have been presented by the Energy Commission's expert groups. They ~~seem to~~ indicate that the influence on the environment of coal or oil fired power plants in ordinary operation are worse than that of nuclear power and that it in practise would be impossible to abandon nuclear power in Sweden up to the year 1985. If the abandoning was put off to 1990 it would be necessary to carry through ~~rationing of electricity~~, extensive regulation and control and to make investments of about 60 billion Skr. ~~In addition decisions to build fossil fired power plants would have to be made already this autumn without giving time to investigate the influence on the environment by these plants~~.

Recently, the chairman of the Energy Commission told the government that ~~twelve of its fifteen~~ a majority of its members had come to the conclusion that no radical reconsidering of the energy policy which was approved by the parlament in 1975 ought to be made. ~~A sufficient knowledge to~~ form a

~~basis of a decision on an extensive utilization of renewable energy sources will not be available within the next ten years. Until then, a more definite choice of action as to the role these energy sources should play in Sweden's future energy supply ought to be postponed~~. No firm decision for or against nuclear power ought to be taken until more facts are available~~. In an energy system which totally will give least inconvenience~~ the burning of oil and coal would have to be reduced as much as possible. ~~Further a continuous installation of nuclear power would mean a much less strain on Sweden's economy than the use of oil or coal. A rapid withdrawal of nuclear power and replacing it with coal would mean a destruction of capital of about 68 billion Skr.~~ The Energy commission will present its final report next week.

n the possibilities of
e renewable energy
urces. For environmental
d economic reasons

4. In the government's bill for 1978/79 on grants to the State Power Board no money will be allocated for the Forsmark 3 reactor. The Board, however, can use about 73 million Skr left from the present budget year to continue to keep the project going on a limited scale for manufacture of components at the subcontractors until this autumn when the parliament will decide about the coming energy program.

5. It is expected that the government in its bill on energy R&D for July 1978 - June 1981 will propose a much higher grant than for the present three year period, probably about 1 billion Skr. The main efforts will be on solar heat, biomass and wind energy. Since almost a year Sweden has a pilot wind power plant of 65 KW operating and there are further plans to build ~~three~~ two more plants of 1 - 2 MW. Large sums would also be given to energy conservation measurements.

   The state-owned R&D company. AB Atomenergi, will change its name to Studsvik Energiteknik AB. The new name reflects the widening of the company's activities to comprise not only nuclear but also other energy techniques which however started already during the previous government.

6. Sweden has at Ranstad one of the largest uranium deposits in the world estimated at about 300 000 tons of uranium. The ore, an alum slate, is, however, very low grade and is not economic to work at the present uranium prices. R&D work has been going on since 1965 in a pilot plant and about 100 tons of uranium ~~in the form of yellow cake~~ has been produced. During the last years the work has aimed at extracting also all other useful components from the ore such as vanadium, molybdenum, nickel etc as well as to produce fertilizers based on nitrogen, phosphorus and potassium in the slate and utilize its organic content by combustion or through other processes.

Last autumn the local authorities in the Ranstad region voted against a proposal to mine one million tons of alum slate and later the government rejected the application. The project leaders have now asked for 129 million Skr for the next three year period to form a R&D institute which would investigate the possibilities of utilizing all useful components of the slate. The sum ~~is expected to be~~ granted as a loan.

has been

7. The two dominating trade unions have both expressed their strongest support to maintaining the nuclear program of 1975 of 13 reactors, ~~and~~ The Federation of Swedish Industries has even proposed an additional installation of seven nuclear reactors up to 1990. ~~to secure a cheap and safe supply of electricity to the industry and reduce Sweden's dependence oil as much as possible.~~ Industry as well as the trade unions also want mining at Ranstad to start on a commercial scale.

has also proposed that the
chnical and economical
tential of utilizing ASEA-ATOMs
heat producing reactor in
regions should be studied.

8. The gorvernment's energy policy has of course not been stimulating for the nuclear industry because of the uncertainty it has created. The half-hearted support from the government for export efforts has neither made it easier for the industry to manifest itself on the international market. In one respect, however, has the government perhaps unintentionally helped the nuclear industry. Because of the Nuclear Stipulation Law the Nuclear Fuel Safety project was formed and the extensive work which has been done withing the project has given Swedish industry an outstanding knowledge of high-level waste management which ~~will also~~ be of interest to other countries. ~~with nuclear power programmes~~. Thus for example ERDA of the USA has participated in the work at the test mine station a participation which the DOE has continued.

has proved to

As to the present reactor projects there have been no major change. In ASEA-ATOM work is going on as planned on Forsmark 1 and 2 the Finnish reactors TVO1 and 2. Work on Forsmark 3 and Oskarshamn 3 is also going on although, according to a stretched out scheme.

ASEA-ATOM has developed further its BWR 75 reactor, ~~which is well equivalent to the best of the world's reactors~~. The company has further - in co-operation with AB Atomenergi and the Finnish Technical Centre - developed a nuclear only heat supplying reactor, SECURE, which is designed for district heating of cities of about 100 000 inhabitants or more. A special feature of this reactor is its outstanding safety properties which would allow it to be built in urban areas.

ASEA has also developed a new technique for a safe containment of spent nuclear fuel. Under high pressure (about 1 000 bar) and temperature (1 350°C) the waste is compacted together with suitable materials to form dense solid bodies having a very high leach resistance to the ground water and a greater mechanical strength than for example, granite and being harder than all other natural materials except diamonds.

~~Uddeomb is proceeding~~ its manufac~~ture of the reactor~~ pressure vessel for Forsmark 3 and Oskarshamn 3 and for some German plants. As a consequence of the diminishing nuclear market the company has taken certain pressure vessel orders from process industries and has also ~~activated its service department~~.

9. The nuclear debate has continued to be very intensive since the change of government. ~~In the leader columns of the press it has even increased.~~ With a few exceptions the daily papers ~~in general~~ are very critical of the governments nuclear energy policy. The radio and television has some what toned down their usual anti-nuclear attitude.

Public opinion polls which are now and then being made indicate that the majority of the Swedish people consider nuclear power to be neccessary to make Sweden able to keep its position among the industrial nations of the world. The polls also show that a large majority of the public knows very little or nothing of nuclear energy and are therefore hesitative to its use.

The discord within the environmental organizations has not noticeably weakened the anti-nuclear movement. The Environment League has so far been most active and has ~~e.g.~~ arranged two demonstration marches against Barsebäck. In the first one in September 1976 about 5 000 demonstrators took part, in the second one last September about 15 000. About 30 % of the demonstrators came from Denmark (Copenhagen lies only about 20 kilometers from Barsebäck). ~~There were no disturbances during the marches and as a matter a fact the Swedish anti-nuclear groups have never shown any militant attitudes.~~

resented a program for
weden's future energy
pply based on renewable
ergy sources only. For this
rk it got a grant of 0,5 million
y the energy commission.

Recently pro-nuclear groups have been formed among the personnel of ASEA ATOM, the nuclear utilities and AB Atomenergi with the main aim of informing the public on energy matters and of correcting faulty statements in the media.

They are just establishing an "umbrella" organisation "Energy and society" which will act through the mass media and other possible channels.

Further a pro-nuclear Society for the Development of Nuclear Power (FKU) has been formed which is supported by the American and the European Labour unions. It has so far only about 100 members but is very active.

Lately a "Committee for energy supply" has been formed which plans a nation-wide advertising campaign with a declaration, signed by several hundred top figures from the establishment. ~~It~~ This is an indication of how seriously the government's energy policy is looked upon by large society groups conscious of their responsibility.

Conclusions

As may have been evident of my lecture, Sweden is in a very difficult and rather unique situation, having a government whose members have different opinions on which energy policy to follow and who therefore have to try to find a compromise whenever decisions on energy matters have to be taken. Consequently, one can only guess what the future development will be.

Decisions on the start of operation of Ringhals 3 and Forsmark 1 ought to be taken soon but I do not think the government parties will be able to compromise on this matter. My personal guess is therefore that it will be postponed until this autumn when the parliament will decide on an energy policy. This would cost Sweden hundreds of millions of kron~~o~~er.

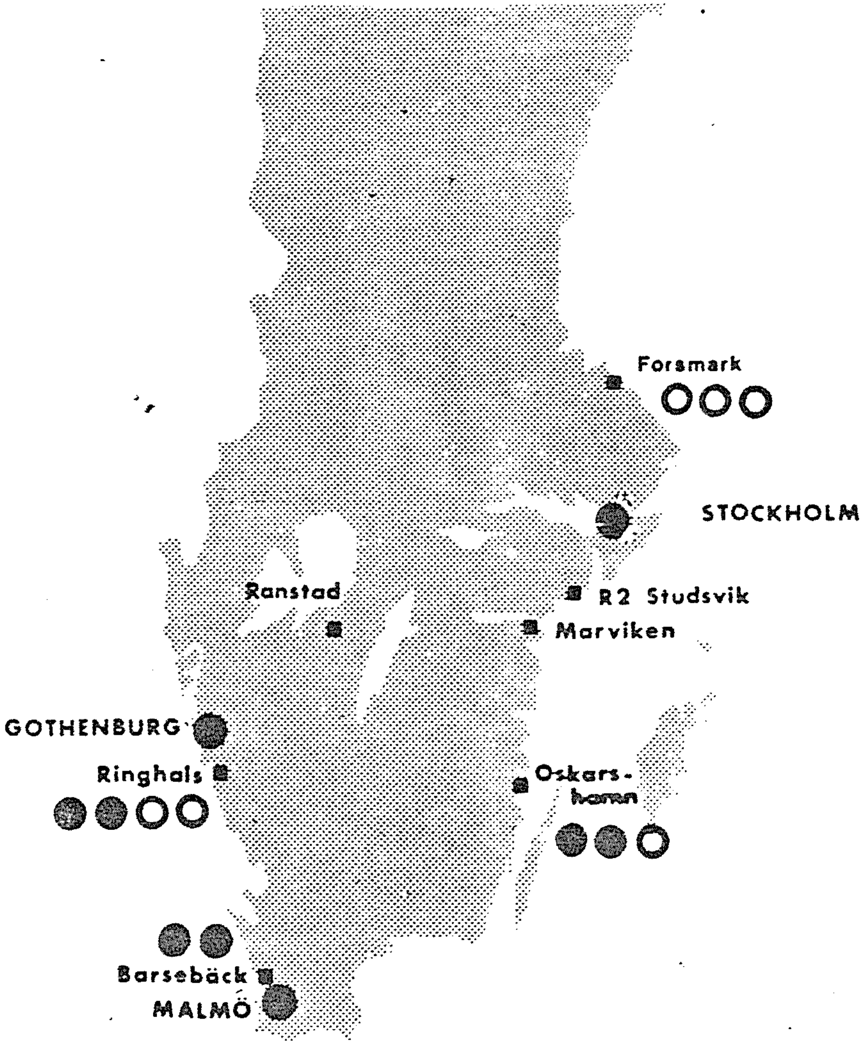
The overshadowing question will be which proposals the government will present in its energy policy bill to the parliament this autumn when it has studied the energy commission's report which by the way will probably be a disappointment to the Center party. The fact is that the Center party has committed itself so heavily to abandoning nuclear power that they cannot reasonably remain in the government in case the parliament would not agree to a non-nuclear energy policy. In such case Sweden may get a minority ~~and probably Liberal party~~ government until the next general election in the autumn 1979. It may also be that the present government manages to postpone all decisions concerning energy and nuclear power until the election.

a factual Such ~~a~~ moratorium of nuclear power would of course cost a fortune.

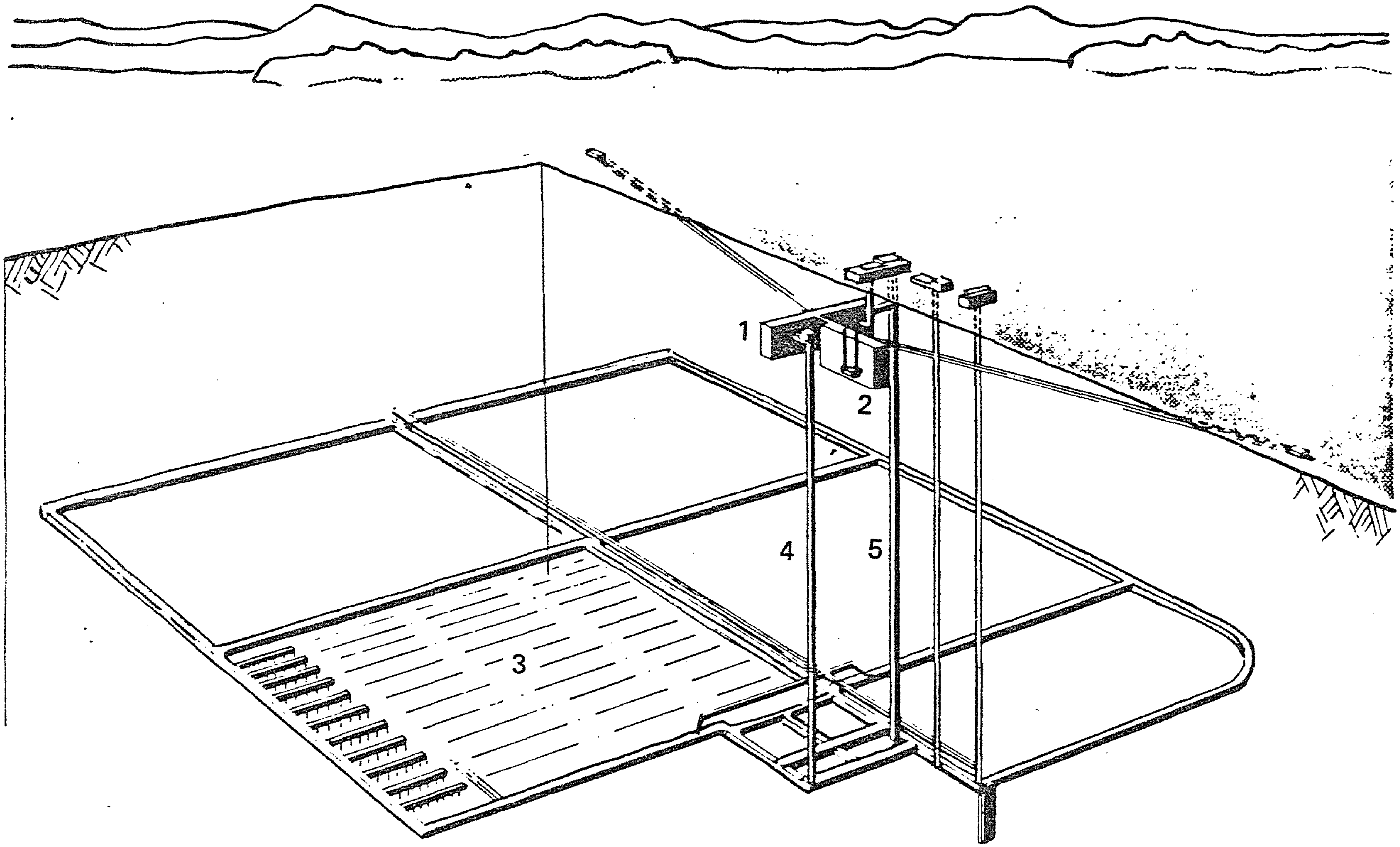
Representatives of the Center party have recently hinted at the possibilities of a referendum w~~h~~hich would be advisory only but I do not think this is ment in earnest.

Whatever the development will be my guess is that we will finally end up with ~~a nuclear power expansion~~ according to the plan of 1975 ~~i.e. with~~ 13 reactors in operation ~~in~~

instead of 1985. although 1990. The Swedish people will not accept a decrease in their standard of living in the future and they will for certain realize that they cannot therefore do without nuclear power.

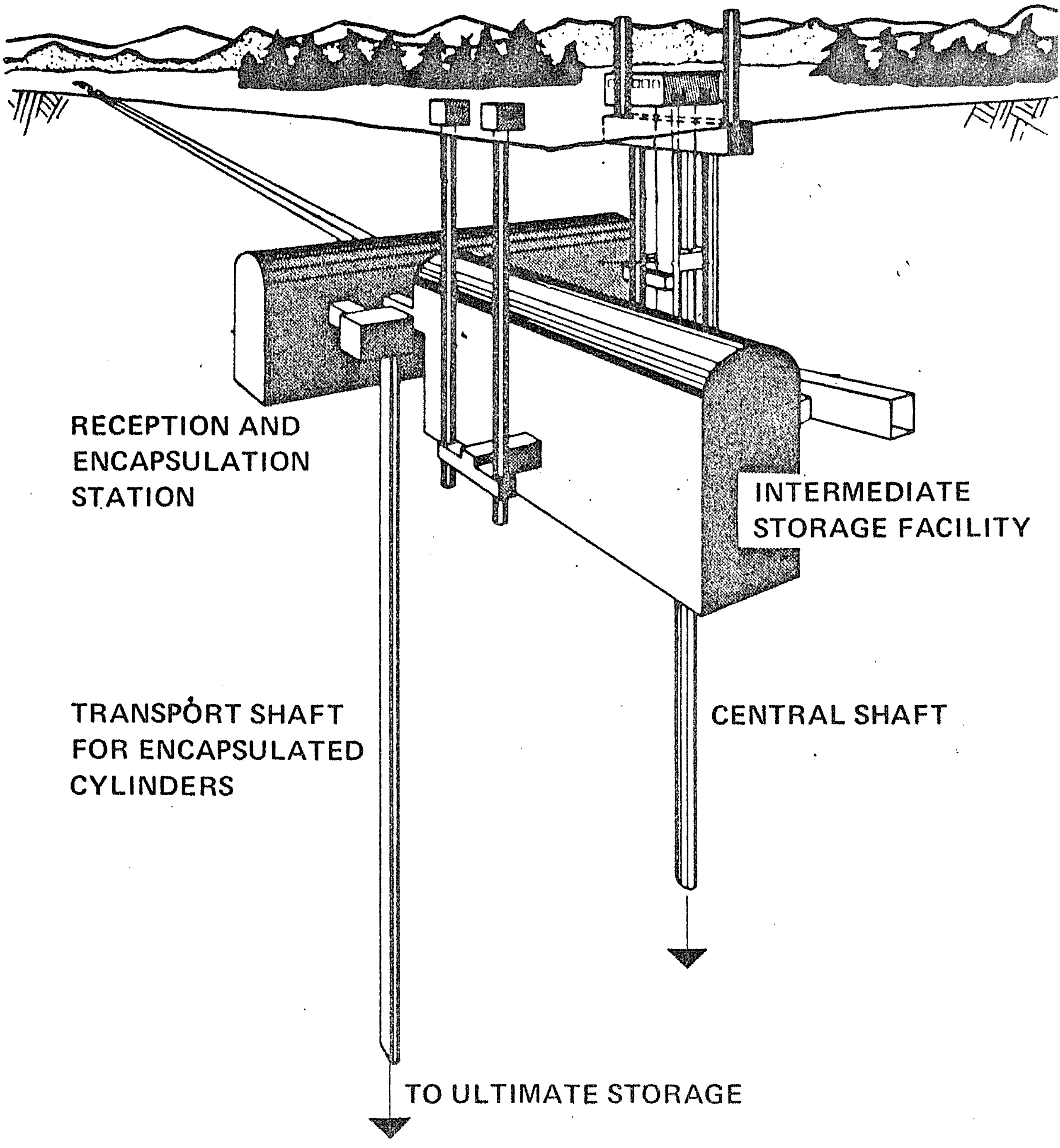

Forsmark
STOCKHOLM
R2 Studsvik
Ranstad
Marviken
GOTHENBURG
Ringhals
Oskarshamn
Barsebäck
MALMÖ

		MW net	Reactor plant contractor	Owner	Start of regular operation
Oskarshamn	1	440	ASEA-ATOM	OKG	1971
»	2	580	»	»	1974
»	3	1060	»	»	?
Ringhals	1	760	»	State Power Board	1976
»	2	820	Westinghouse	»	1975
»	3	910	»	»	1978?
»	4	910	»	»	1979?
Barsebäck	1	580	ASEA-ATOM	Sydkraft	1975
»	2	580	»	»	1977
Forsmark	1	900	»	State Power Board	1978?
»	2	900	»	»	1979?
»	3	1050	»	»	?



1 RECEPTION AND ENCAPSULATION STATION
2 INTERMEDIATE STORAGE
3 ULTIMATE STORAGE
4 TRANSPORT SHAFT FOR WASTE CANISTER
5 CENTRAL SHAFT

ULTIMATE STORAGE FACILITY



INTERMEDIATE STORAGE FACILITY

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"NUCLEAR POWER IN THE UNITED STATES: THE SCOPE AND TREND OF THE NATIONAL DEBATE"

by

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presented at

JAPAN ATOMIC INDUSTRIAL FORUM
11TH JAIF ANNUAL CONFERENCE
March 16, 1978
Tokyo, Japan

As one who last visited this extraordinary and lovely country almost 27 years ago, I accepted your invitation to speak here with special enthusiasm. So much has changed for the betterment of so many in what now seems like so brief a period of time that I take heart, even while looking at the storm of problems that presently besets the nuclear industry, for what can be accomplished if we have a sure sense of the future.

In reporting to you about the scope and trend of the national nuclear debate in the United States today, I shall try briefly to set that debate in the perspective of both the times through which it has evolved, and the logic, which, in my judgment, should direct its ultimate course.

~~In a real sense, the nuclear debate in the United States began in the minds of three immigrants, Leo Szilard, Eugene Wigner and Albert Einstein, and it was first resolved in Einstein's now famous letter of August 2, 1939, to President Roosevelt that lead to the establishment of the Committee on Uranium.~~

~~The wartime shrouds of secrecy that hid the decisions of the Manhattan Engineer District have now almost all been lifted. In 1945 and 1946, however, the public Congressional debate that lead to passage of the McMahon Act was simply the tip of the iceberg in the cross currents of interests, responsibility, ethics and high public purpose that went into establishing the Atomic Energy Commission as an extraordinary, civilian, collegially-governed, independent agency responsible to an equally extraordinary Joint Committee of the Congress.~~

~~The basic institutional framework of the McMahon Act was designed to assure the development and direction of nuclear energy in the United States, both in secrecy and in the public interest. In the rhetoric of today's political climate, secrecy and the public interest have become almost mutually exclusive values. But in the immediate post war years, there was a sense of trust in the~~

After the war, major decisions were made about nuclear policy in the United States in 1946 and again in 1954 without any public debate or even a floor fight in the Congress. The principle of the early years was to protect the public interest in secrecy relying on the honorable men of the Establishment. WE can't do that today because the Establishment has become suspect and secrecy is even more suspect.

reliability of the honorable men of the establishment to pursue the public interest; there was a sense of unity in America's obligation to assist a world rebuilding; and there was the further unifying force of the cold war.

In 1953, President Eisenhower's famous "Atoms for Peace" speech before the United Nations in New York initiated a second public debate. The issue was simply put: the United States recognized that its nuclear monoply would eventually end and that international cooperation in the peaceful uses of nuclear energy would provide the surest institutional path for all nations to pursue toward a constructive nuclear future. The vision of abundant, low cost energy was held out. The President's personal prestige was enormous and was fully committed. American nuclear isolationism was ended. There was no floor fight in the Congress when the McMahon Act was substantially amended by the Atomic Energy Act of 1954 to seal the decision.

But for the first twenty years or so of nuclear policy making ~~During this time~~, the public perception of nuclear science, whether peaceful or military, was largely one of awe. It was assumed to be secret and if it wasn't, no one could understand it anyway.

My purpose in sketching in this background is not to suggest that there was truly a public nuclear debate in the United States during those years. On the contrary, I don't believe you could have started a public debate about nuclear energy then if you had wanted to. The public simply wasn't in the mood for it.

The debate as we (now) know it had origins that ~~today had quite different origins, most of which~~ had little to do with nuclear power itself and particularly with the ~~And to anticipate a major point I want to make this morning, the nuclear power debate today is again, a masque of a much broader debate which really doesn't have very much to do with the~~ nuclear power issues that everyone talks about.

~~Well then, where and when did it all begin? About ten years ago we saw the first rush to nuclear power by U. S. utilities. In 1967, the AEC received 29 construction permit applications; and in its annual report for~~ In 1968, the Atomic Energy Commission ~~noted that "During this, its most active year of licensing and regulation, the AEC~~ authorized construction of 23 nuclear power reactors with a combined design capacity of more than 18,000 MWe. By year's end, 44 nuclear power units were under construction in 19 states . . ." ~~Nuclear power was on its way to the grass roots, and the awe and easy ignorance of the past were certain to yield to increased discussion, understanding and some opposition.~~

That ~~The~~ regulatory performance ~~of 1968~~ is enviable today, but it was possible because nuclear power was not a public issue then. ~~a clue to its success is found in other passages of the AEC's reports of a decade ago. In June of 1967, for example, the Commissioners received a report from "a three-member panel that had been appointed from outside the government in the spring of 1966 to study AEC procedures for handling contested cases involving applications to construct and operate nuclear facilities." The members of the panel were a utility executive, a former AEC general counsel, and a Washington lawyer who had been legal projects manager for the Atomic Industrial Forum. It would not today be considered an outside panel, but its composition was not challenged then. Intervenors were not yet a lively part of the scene.~~

What changed things?

To begin with ~~But even then~~ there was a unique aspect to the process of nuclear power plant licensing that came ~~began~~ to serve increasingly as a lightning rod for public controversy. This was the mandatory public hearing of each construction permit application by an Atomic Safety and Licensing Board in the vicinity of the proposed site. Looked upon initially as a new experiment in administrative law, and purposed in important part as a public education effort to assuage the fears or concerns of prospective neighbors of nuclear power plants, the ASLB's came to offer~~ed~~ a convenient Federal forum for taking on the establishment. At the outset, intervenors were largely concerned with typical local zoning and land use issues. They didn't want a plant built near them because they felt it would adversely affect their property or business interests. The decade of the 60's produced a different atmosphere. ~~But the mood of the country began to change and the changes began to catch up with the nuclear power establishment~~.

As the 60's began, we were becoming a nation that was tired of being satisfied with itself. There were several factors that contributed to the process: the emergence of television as the dominant news and opinion forming medium; the shift in political demography as the first wave of the U. S. population explosion -- the first of the war babies -- began to reach maturity; the high hopes for youth and change in John Kennedy's style and rhetoric, the passion for social justice channeled into civil rights for America's black minority.

All of these interacted with one another to give birth to what came to be called the "new politics" of the 60's. Television gave real-time visual immediacy to the assassination of a youthful President and the assassination of his assassin, and with it conveyed, particularly to young viewers, a sense of outrage, fear and betrayal. At the same time, the medium was pointing up the inequalities in the distribution of wealth among Americans, particularly minorities, whose life style fell well below the "average" depicted in a number of television series about typical American families. The black civil rights leaders were among the first to understand the new importance of theater in politics. Their ultimate successes created a sense of ~~hope~~ the possibilities for what might be accomplished by the politics of theater. The assassinations of Robert Kennedy and Martin Luther King shocked and enraged the young even more and contributed to a sense of mistrust for the established order of things. ~~so so powerful, yet so incompetent or so callous~~.

All of these attitudes and trends came together and were reinforced by the war in Vietnam where the most powerful country in the world was sacrificing its young for a cause that seemed both fruitless and meaningless. The decline of the traditional American establishment during the course of the Vietnam involvement has been chronicled by a number of observers. The relationship of trust between the governed and the governors became frayed. The Watergate tragedy simply completed the process.

But there was also a new element that Vietnam underscored: the weakness of technology. If technology was all that good, why not press a button and end the war. Television kept showing how technology could take lives but in a personal sense -- to young Americans watching -- it could not end the war and spare lives. They continued -- despite technology perhaps because of it -- to remain the generation at risk.

There were other factors contributing to change, among them simply the rapid growth of the country during the 60's. It meant an improved standard of living first, then crowding on the highways and in the cities, increased competition in the schools. ~~and anonymity in the shopping center two miles from home~~. Big development, big institutions, bureaucracy, irresponsiveness -- a desire to get away -- only to find polluted rivers, crowded, littered beaches, traffic jams, and all of these things, at least in part, could be laid at the door of too big, too fast -- technology.

The locus of the new politics that grew out of this evolving melange of people, factors and events was the university campus. The impressions on those who were there in the late 60's and early 70's are indelible; and they have shaped the thought processes, ethical reflexes and trust attitudes of a populous new generation, many of whom have now come into positions of significant political power.

~~Nuclear power still wasn't much of an issue in 1968, however, when the new politics became a force in the land, when Lyndon Johnson declined to run again, and when the politics of theater witnessed perhaps its high water mark at the Chicago Democratic Party Convention.~~

The critical development that connected nuclear power with the maelstrom of change of the '60's was the passage of the National Environmental Policy Act of 1969. On July 23, 1971, the United States Court of Appeals for the District of Columbia handed down its now famous ruling on the Calvert Cliffs case which directed the Atomic Energy Commission to incorporate in its licensing process the responsibility for evaluating and assessing the total environmental impact of nuclear facilities. By its terms, it opened up the nuclear licensing process to a virtually limitless set of questions, ranging from economics to aesthetics. It provided a framework within which one could debate the social costs and consequences of any new technology almost endlessly before it could be further deployed throughout the country.

The Atomic Energy Commission had looked upon its regulatory mission up until Calvert Cliffs, a limited one, ~~not as one of determining that nuclear power plants would proliferate over the landscape come what may. The scope and rate of nuclear building were to be determined by the private sector on the basis of traditional entrepreneurial considerations, albeit with a friendly government~~

~~standing by. As regulator, the Commission took its role~~ very seriously. ~~But it defined its role very narrowly to one of assuring that~~ If nuclear power plants were built, the Commission's job was to assure they could be constructed and operated "without undue risk to the public health and safety."

Calvert Cliffs changed all that. ~~The Commission's judicial restraint in regulatory matters was now fundamentally altered~~. The nation had, as a James Schlesinger said, embarked on developing a whole new body of environmental law. Nuclear power was just coming into the mainstream. It became a part of the larger debate~~;~~ i~~n fact more than th~~at.

In fact ~~Because of the unique experiment in administrative law which~~ the Atomic Safety and Licensing Boards ~~were engaged in, nuclear power~~ provided to those skeptical of technology, concerned with radiation, dubious of the establishment, angry with bureaucratic insensitivity, and suspicious of bigness not only a target, but more importantly, a federal process within which they could test their own ideas while contesting what they felt were the false values of the established system.

Nuclear power was being advanced by entrepreneurs who by definition sought profits. Their interests were therefore limited and self-serving. The regulators' penchant for limiting the inquiry to questions of radiological health and safety amounted to complicity in a "cop-out." The big public policy questions weren't being addressed.

As the nuclear debate moved into the regulatory process after Calvert Cliffs, those opposed to nuclear power correctly understood something else we did not: ~~that the nuclear establishment did not; namely~~, that the regulatory process is itself highly political. Regulators are government officials. They try to do what the people wish, and their perceptions of the popular will are formed by what they read in the press, what they watch on television, and what critical Congressmen -- ~~as elected representatives of the people~~ -- ask them about or tell them to do.

~~The recruitment of Ralph Nader and his consumerist-campus crusade to the antinuclear movement was a major political achievement. But Nader, though perhaps the best known of the antinuclear advocates, is certainly not the movement's leader nor necessarily its most effective spokesman.~~

Nuclear power became an issue for a legion of ~~groups and~~ organizations: Ralph Nader and his many groups, the Union of Concerned Scientists, the Friends of Earth, the Sierra Club, the National Resources Defense Council, the National Council of Churches, Another Mother for Peace and so on. In many cases the small antinuclear leadership perceived the importance of these issue-oriented organizations on the political process and ~~professionally~~ persuaded their leadership that opposition to nuclear power was the right kind of issue for them to take up.

Characteristic of many of these organizations was the willingness, ~~even the eagerness,~~ of their spokesmen to make use of any public forum, and especially any legislative hearing to air their cause. ~~And~~ They lobbied effectively with congressional staffs, took part in candidate elections, cultivated working journalists and practiced the politics of theater that had become so important with the advent of the television age. Though they were relatively small in total numbers, their effect on the regulatory process was very significant. They have now almost brought it to a halt. ~~and a tribute to their correct perception of the changing politics of our time.~~

There was another political trend that the nuclear opposition understood first: ~~and that is what I call the growing centrifugal force in American Government.~~ the growing importance of the states.

~~Fifteen years ago, any American politician upholding states rights was almost certainly conservative, Southern and segregationist. Today, the rights of the states against the Federal Government are asserted as a liberal cause and one for which perhaps a majority of Americans hold great sympathy. Bigness and irresponsiveness have caught up with the Federal establishment.~~ But here They ~~the antinuclear strategists~~ made their first major political error. In seeking to develop antinuclear legislation at the state level, they seized upon the initiative process.

In 1976, antinuclear initiatives were sponsored in seven states representing twenty percent of the total electorate, ~~in the United States~~. All seven initiatives went down to defeat by 2-1 margins, a rather stark rebuke for the claims of the antinuclear lobby to represent the public interest. The consequences of their error were several. ~~not limited, however, to sullying their claims to represent the public interest~~.

First, of course, they were beaten, not narrowly but by a convincing margin.

Secondly, the nuclear industry got an in-depth taste of politics.

Engineers, scientists, technicians, construction foremen and secretaries made speeches, participated in debates, passed out bumper stickers, walked precincts, took out newspaper ads and found that they could be a part of the political process, they could be successful at it, and, perhaps most importantly, they liked it.

Thirdly, the pronuclear people were not alone. The structure of the campaign in each of the seven states involved establishing a broadly based committee representing business, labor, the minorities, the professional and engineering societies, and retirees. The business-labor-minority coalition has become a permanent political force in the United States with existing organizations in several states. It represents a powerful continuing pronuclear constituency.

Fourthly, public opinion analyses were done in each of the states immediately after the elections to find out what had happened. It became apparent that the antinuclear constituency was both thin in numbers and narrowly based in the political spectrum. In California, for example, the political spectrum is almost a perfect bell curve with about eight percent at the left, another eight percent at the right, and the remaining eighty-four percent moderately liberal to middle of the road to moderatley conservative. The antinuclear movement captured only the most liberal eight percent of the spectrum and this only by a 6-4 majority.

Finally, the post campaign analysis of voter perceptions showed that the pronuclear side had gained credibility on the safety issue. ~~The nuclear insurance or Price Anderson -- if nuclear power is safe, liability for nuclear accidents should be fully borne by the industry -- never caught on.~~ The economic issue was an important secondary consideration. And overwhelmingly people wanted to keep the nuclear option open.

Some thought the polls had conferred a mandate on nuclear power and the debate should be over. The nuclear opponents, however, had also learned something. While they were weak on the jobs and energy issues and needed a positive program for both, nuclear waste disposal was the most vulnerable issue on the pronuclear side. In California they succeeded in getting state laws enacted that could use that issue to stop any further nuclear power plant construction in the state.

Nineteen seventy-six was not ~~exclusively~~ only a nuclear initiative year. We also chose a President in our first post Watergate national election. The challenges to the new President in seeking to restore trust in government, to continue the healing process begun by President Ford, to address the complex energy problem, to initiate reform in government services, and to restructure the government bureaucracy posed the most difficult domestic agenda for any U. S. President for at least a quarter of a century. ~~and perhaps since the great depression of the 30's~~.

During his campaign, President Carter sought to develop a very broad constituency and he was elected because he did so. In forming his new administration, he was fully aware of the importance of involving the liberal intellectuals who, as a result of Vietnam and Watergate, had been largely in self-exile from the formal apparatus of government for almost a decade. Both his energy policies generally and his nuclear policies in particular reflected the inputs of many from this constituency, newly returned to formal power. He laid heavy stress on conservation; he sought to have the American consumer bear the effects of paying world clearing prices for petroleum, he placed new reliance on our abundant coal resources, and he positioned nuclear power as the option of last resort -- a circumstance which many in his Administration now contend is upon us. He dispatched the Clinch River Breeder Project but continued breeder research. He suspended reprocessing but sponsored increased study of alternative fuel cycles, many of which would require some form of reprocessing. ~~But above all, in addressing nuclear power,~~ And he brought front and center the only real issue that ~~to my mind~~ is endemic to the nuclear debate: ~~And that is~~ the issue of proliferation.

~~I will not comment on the substance of it here except to say that trust is absolutely essential to flourishing commerce. So if nuclear power is to go forward as I believe it must, and with it lively commerce in nuclear materials, equipment and technology, then examination of the proliferation problem seriously and exhaustively on a national and international level is an inevitable, desirable and probably continuing activity. It is an essential element in the process of building trust among nations and trading partners.~~

So today, in the United States nuclear energy has become a part of a much larger debate on energy, international security, life style and indeed the future of our country~~, and our proper responsibilty for the world we inhabit and the generations who will inherit it~~. But it is fundamentally a debate about growth with the bottom line of the environmental movement now emerging as anti-growth, anti-big technology, and anti-nuclear as a subordinate argument.

The true issues are not reactor safety or uranium supply or nuclear power costs or low level radiation or high level waste disposal. Rather, they are whether the creation of wealth through science, technology, industrialization and commerce is reaching the point of infestation. Those opposing nuclear power believe it is, although they have not convinced the poor or the disadvantaged of their view. One man's infestation, after all, may be another man's livelihood. That is why the labor-business-minority coalitions in the United States are pro-growth and pro-nuclear. ~~Even in what is still the richest country in the world~~, The heavy majority is not yet prepared to say that we have reached that post affluent paradise where social institutions need only be concerned with the division and not the creation of wealth.

The advocates of limitations are extremely able, however. They have made few political errors in their ascent to great influence. Nor is the syndrome confined to my own country. We live in a world that is increasingly in instant visual real-time communication. The youth movement, the new politics, environmentalism and zero growth are highly contagious ideas that are spreading, particularly in the wealthy nations of the Northern Hemisphere. ~~Much of what has gone into the evolution of these ideas was campus nurtured, and the intellectual centers of the world communicate with one another.~~

What then will be the ultimate course of this broad debate now clearly emerging in the United States? We have for the first time in the history of the planet the scientific knowledge and the technological capacity to envision a planetary abundance, where satisfying the material wants and needs of even a much larger population should come within our grasp. It will, however, take many decades, perhaps centuries, great trust and great good luck to bring about. It will above all increasingly require exercise on a worldwide basis of the two timeless tasks of governance -- developing the social institutions for the creation of wealth and adjusting them for the equitable distribution of wealth. We have today only the first faint glimmer of a world of sufficiency despite ~~the useful and~~ the provocative meditations of brilliant social essayists like Amory Lovins. Sufficiency is not here yet. ~~even though in my country it may appear to exist to some among an advantaged class in enclaves like Cambridge or Palo Alto.~~

So there is finally a paradox in the politics of the debate: those who think the vision of sufficiency is at hand could prevent its coming about through their treatment of nuclear energy within the broader context of the political debate about growth, energy and the morality of life styles.

The continued creation of wealth at a politically acceptable rate will require the even more effective use of energy. Our ability to use energy more effectively in turn depends on the progress of our science. And science is measured by our deepening understanding of the structure of matter. In a prophetic essay, written some thirty years ago, entitled "A Sense of the Future," Jacob Bronowski said, "The atomic bomb is not a great achievement of science. But science has made a great discovery: the fundamental discovery that we can tap atomic energy. That is an achievement, not of bickering nations, but of man. And we have the whole history of science to tell us that every fundamental discovery has in the end brought men more good than harm . . . if we are willing to look forward."

Looking forward cannot leap the conflicts, deprivations, ignorance, ambitions and wants of the world we live in. Nor can it pretend that the achievement of man in his ability to tap atomic energy can be erased by a romantic hope for a future that will somehow come by itself through soft or alternate energy technologies based upon a more primitive understanding of the structure of matter.

So I believe that the ultimate course of the nuclear debate and the energy debate in the United States will be positive. Nuclear energy is the only post-hydrocarbon energy technology we have at a time when we surely need one. As Glenn Seaborg has said, nuclear energy came "in the nick of time."

The challenge to us in the turbulent marketplace of politics and debate is to solve the paradox presented by the critics. Their vision of a world of material sufficiency entails the harnessing of the nuclear energy they fear and oppose in order to create the additional wealth that is essential to their vision. So long as deprivation continues to exist broadly and deeply

on a planetary basis -- and it does -- the creation of wealth is an essential human obligation. Political stability in a world where nuclear arms exist requires it. Our obligation, therefore, to pursue the nuclear debate successfully, is one in which we cannot permit ourselves to fail.
Though I cannot say when the trend will turn, I believe it will, because it must.